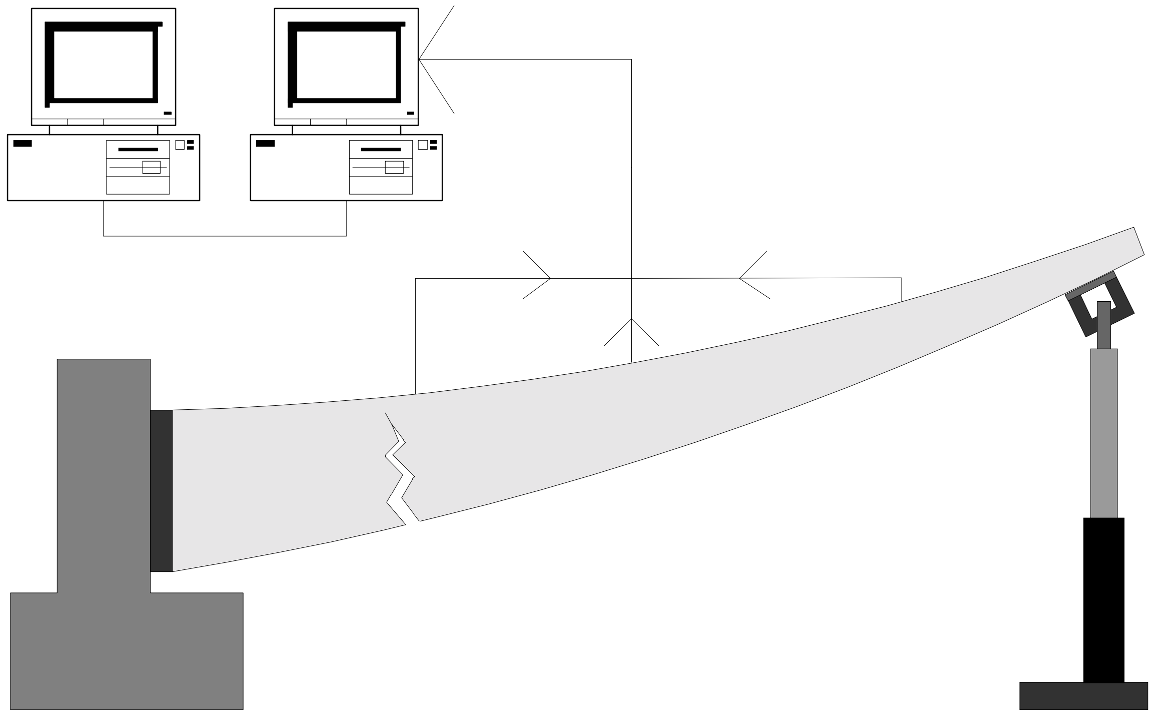
BSTRAIN

Blade Structural Testing Real-time Acquisition Interface Network



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Software Version 2.5

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Background

The Wind Technology Division at NREL has successfully operated a structural test facility for the purpose of testing full scale wind turbine blades. Since its inception in 1991, the structural test facility has performed structural blade tests on over 75 full-scale blade structures for many different turbine manufacturers.

The capabilities of the structural test facility include one-axis and two-axis fatigue testing , ultimate static strength testing, and several non-destructive techniques, such as photo-elastic stress analysis. Fatigue tests use an MTS Systems Inc. closed-loop servo-hydraulic system to apply cyclic loads to blades up to 20-m (66-ft). Constant or variable amplitude loading can be used to apply cyclic loading to the blade. Hydraulic power is supplied to the hydraulic actuators at flow rates up to 100 GPM. Static tests are performed by applying a monotomically increasing distributed load to the blade span. The load is increased until the blade fails or a proof load is achieved.

For either static of fatigue testing, the blade is instrumented using strain gages to monitor blade strain levels, loads, and displacements, throughout the test period.

Version 1 of BSTRAIN implemented the following features:

- Common software base compatible with other NREL and Sandia National Laboratories (SNL) data acquisition projects (LabVIEW).
- User friendly operation.
- 32 channel capability.
- Real-time peak / valley time series processing.
- Automated channel setup.
- Test monitoring capability.
- Continuous data sampling option.
- Real-time display capability (graphical and numerical).
- File statistics and automatic report generation.
- Remote data file transfer via modem.
- Automatic control of video.

The result of this design was BSTRAIN 1.0, which was first implemented in July 1995. After continuous, but periodic improvements through today, BSTRAIN met all of it’s initial objectives and added some unforeseen improvements such as automatic stiffness checks, automatic zeroing and remote test monitoring.

Version 2 of BSTRAIN was first implemented in early 1998. In addition to many minor changes, the software was modified with the following major changes:

- 48 channels capability.
- Two-axis fatigue testing.
- Geometric corrections for two-axis testing.

Scope

This is the complete manual for the BSTRAIN system. It is designed both as a reference for users of the system at the National Wind Technology Center, and as an introduction to the features of the system for non-users.

More hardware specific information can be found in the National Instruments manuals for the PCI-MIO-16XE-10 analog to digital conversion board, SCXI 1121 signal-conditioning module, SCXI 1321 terminal block, and the “Introduction to SCXI” manual. LabVIEW questions are addressed in the LabVIEW 5.0 documentation set.

Specifications

48 Channels:	channel 0, fatigue test displacement (flap),
	channel 1, fatigue test load (flap),
	channel 2, fatigue test stiffness check signal,
	channel 3, static test load,
	channel 4, fatigue test diplacement (edge),
	channel 5, fatigue test load (edge),
	channels 6-48, other signals.
Speed:	fatigue test: at least 500 Hz (per channel),
	static test: at least 20 Hz (per channel).
A/D board:	16 bit, 100 kHz,
	input range is ±5 Volts.
Signal conditioning:	provides various gains from 1 to 500,
	capable of bridge completion,
	capable of shunt calibration.
Data storage:	ASCII header and other miscellaneous files,
	binary data file (2 bytes per sample),
	2.0 Gb hard drive (approximately 1 billion samples).
Software features:	graphical user interface,
	continuous test monitoring,
	real-time display (graphical and numerical),
	standard deviation monitoring (static test),
	real-time peak / valley processing (fatigue test),
	real-time decimation (fatigue test),
	remote test monitoring via modem (fatigue test),
	automatic control of two looping VCRs (fatigue test),
	automatic stiffness checks (fatigue test),
	automatic zeroing (fatigue test),

makes a phone call if the test shuts down (fatigue test),

can set test-shutdown triggers on any three channels (fatigue test),

two-axis geometric load and displacement corrections.

Minimum System Requirements

Requires at least a Pentium 300 MHz with 256 MB RAM and 100 MB hard disk space. Operating system is Windows 95 or 98.

Glossary

2-Axis test: A fatigue test where loads are applied via flap and edge actuators.

2ACD: 2-**A**xis **C**ontrol **D**etermination. A program within BSTRAIN that iterates to determine the correct flap and edge displacement controls needed to reach desired horizontal and vertical loads.

A60: A test facility at the National Wind Technology Center.

autozero: Feature of the fatigue test. If activated, BSTRAIN will attempt to measure new software zeroes (DC offset) during every stiffness check.

BIB box: (**B**lade **I**nterface **B**ox) Optional unit which provides 8 channels of bridge completion right at the blade.

BSTRAIN: **B**lade **S**tructural **T**esting **R**eal-time **A**cquisition **I**nterface **N**etwork.

BSTATUS: Program which displays fatigue test information on a remote computer (via modem).

controls: LabVIEW term for a visual knob or dial. Generally accepts input.

DAQ: **D**ata **A**c**Q**uisition. The computer on the BSTRAIN network which does the actual data collection is called the DAQ computer.

decimation: A data reduction process where you only save every n^{th} data point.

digital signal conditioner box: Basically a pull-up resistor. Uses the 3.333 Volt source from the SCXI equipment to convert a digital signal (switch) to a high/low analog signal.

highbay: A test facility at the National Wind Technology Center.

indicators: LabVIEW term for a visual object which displays information. Does not accept input.

jumpers: Little connectors which are moved to change settings on electronic devices.

LabVIEW: Visual programming language from National Instruments.

MTS 458/498/TRAC: Older hydraulic control equipment.

MTS FlexTest: Newer hydraulic control equipment.

master/slave channel: Terms used to describe the peak / valley detection process. The window of time in which to search for peaks / valleys of slave channels, is dictated by where the peak / valley is found on the master channel.

RAS: (**R**emote **A**ccess **S**ervice) Program that comes with windows and allows remote connection to a Microsoft network.

sample: A analog to digital conversion of a single channel.

scan: One analog to digital conversion of every channel.

SCXI: (**S**ignal **C**onditioning e**X**tension for **I**nstrumentation) Expandable, modular equipment from National Instruments which multiplexes multiple channels, provides gains, etc.

stiffness check: A non-dynamic measurement of load (pounds) per displacement (inches).

VI: **V**irtual **I**nstrument.

Chapter One

1. Hardware Setup

The Blade Structural Testing Real-time Acquisition Interface Network (BSTRAIN) was developed for the National Wind Technology Center. It consists of two networked PC's, a data acquisition (DAQ) machine and an analysis machine, which interface to the test specimen via SCXI (Signal Conditioning eXtension for Instrumentation) equipment. Fig. 1.1 shows a generic SCXI based DAQ system. Excitation is provided to a transducer by the SCXI Module. The transducer then produces an output signal which is conditioned by the SCXI Module. The conditioned signal is then digitized by the Plug-in DAQ Board and can be processed by the Personal Computer.

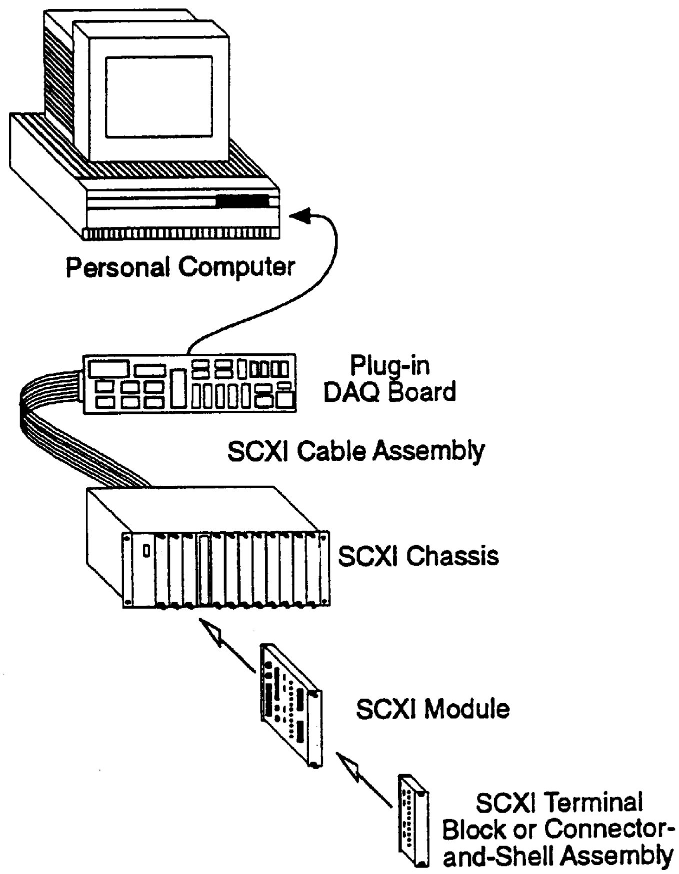


Figure 1.1. Generic SCXI data acquisition system.

BSTRAIN is used to monitor two types of structural tests performed on turbine blades; the static test and fatigue test. The static test is a short-term (i.e. one hour) test where a blade is slowly pulled to a proof load. Data is acquired at 0.5 to 20 Hz from a load cell and various strain gages. The fatigue test is a long-term (up to 6 months) test where a blade is repeatedly cycled with a periodic load at approximately 0.5 to 2 Hz. During a fatigue test, load, displacement, and various strain gages are monitored at about 100 Hz.

1.1 Static Test

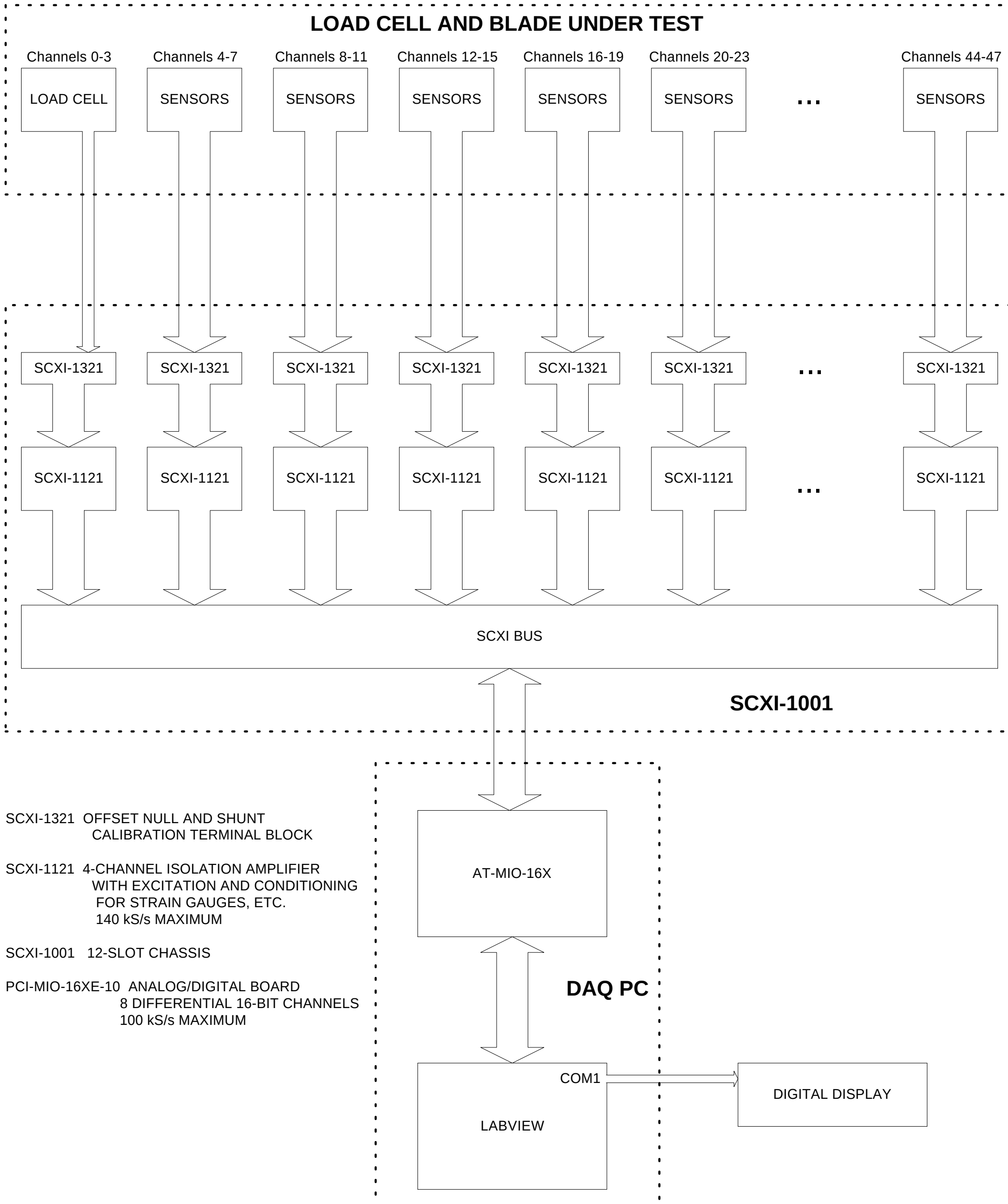


Figure 1.2. Signal block diagram for static test.

Connections for the static test are as shown in Fig. 1.2. Channels 0,1, and 2 are not used for a static test as they are reserved for fatigue tests. The first channel sampled is channel 3, the load cell. Strain gages can then be connected to channels 4-31 as needed. Ideally, a BIB (blade interface box) is used to connect a strain gage to the SCXI equipment as shown in Fig. 1.3, but connections without a BIB box can be made as shown in Fig. 1.4. Connections to the SCXI chassis are made via the SCXI 1321 terminal board (Fig. G.2). Signal definitions for the BIB box cables are given in Appendix A and B.

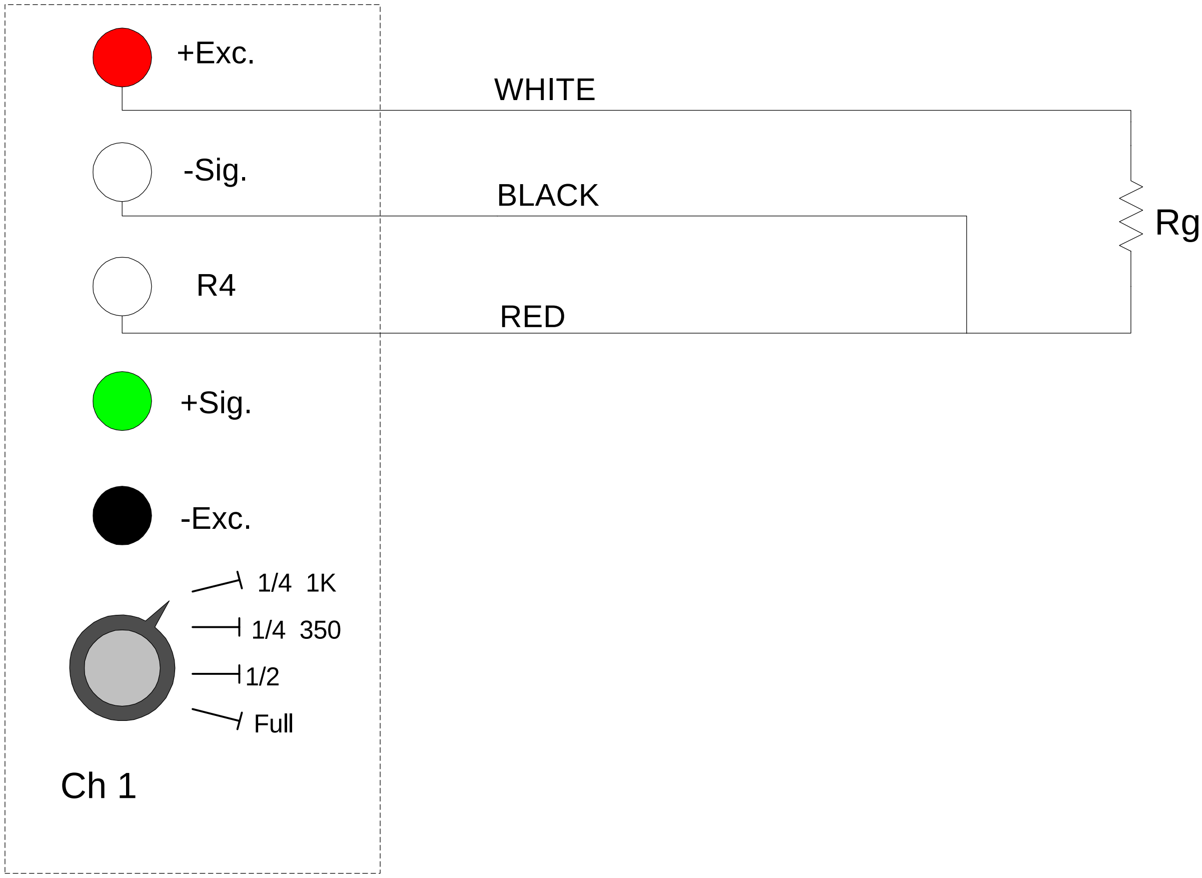


Figure 1.3. BIB box connections for 1000 Ohm, quarter bridge completion.

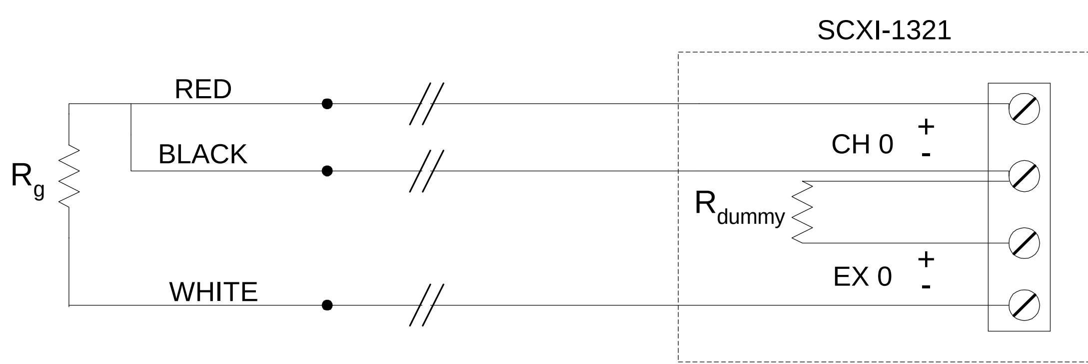


Figure 1.4. 3-wire, quarter bridge strain gage connections, $R_{dummy} = R_g (0)$.

After completing all connections you must decide if you need to move any jumpers in the SCXI 1121 modules. Under normal test conditions, the same settings can always be used and no jumpers need to be moved, but if you are not using a BIB box or will experience abnormal (see next paragraph) loads and strains, different settings are required. Choose your gains using Table 1 and Table 3 of Fig. 1.6. Setting all gains (channel 3 through last channel) to 200 allows a maximum load of ±28111 pounds and maximum strains of ±14300 microstrain. Since this is a 16 bit acquisition system, there are 65536 bits of resolution.

Therefore at these settings you have a resolution of about 1 pound and .5 microstrain (total range/resolution).

Fig. 1.5 is a roadmap to the jumpers on the 1121. Normal settings would be completion network disabled (BIB box used), excitation mode voltage, excitation level 10V for channel 3 (load cell) and 3.333V for strain gages, gain = 200, and filter = 10kHz. **If the load could exceed ±28111 pounds or any strains could exceed ±14300 microstrain, you will need to use a gain less than 200. If the load will not exceed ±2811 pounds or a strain will not exceed ±1430 microstrain, you should consider using a gain of 500 for those channels, giving you more resolution.** Also note that these guidelines are for the particular load cell and strain gages addressed in Fig. 1.6.

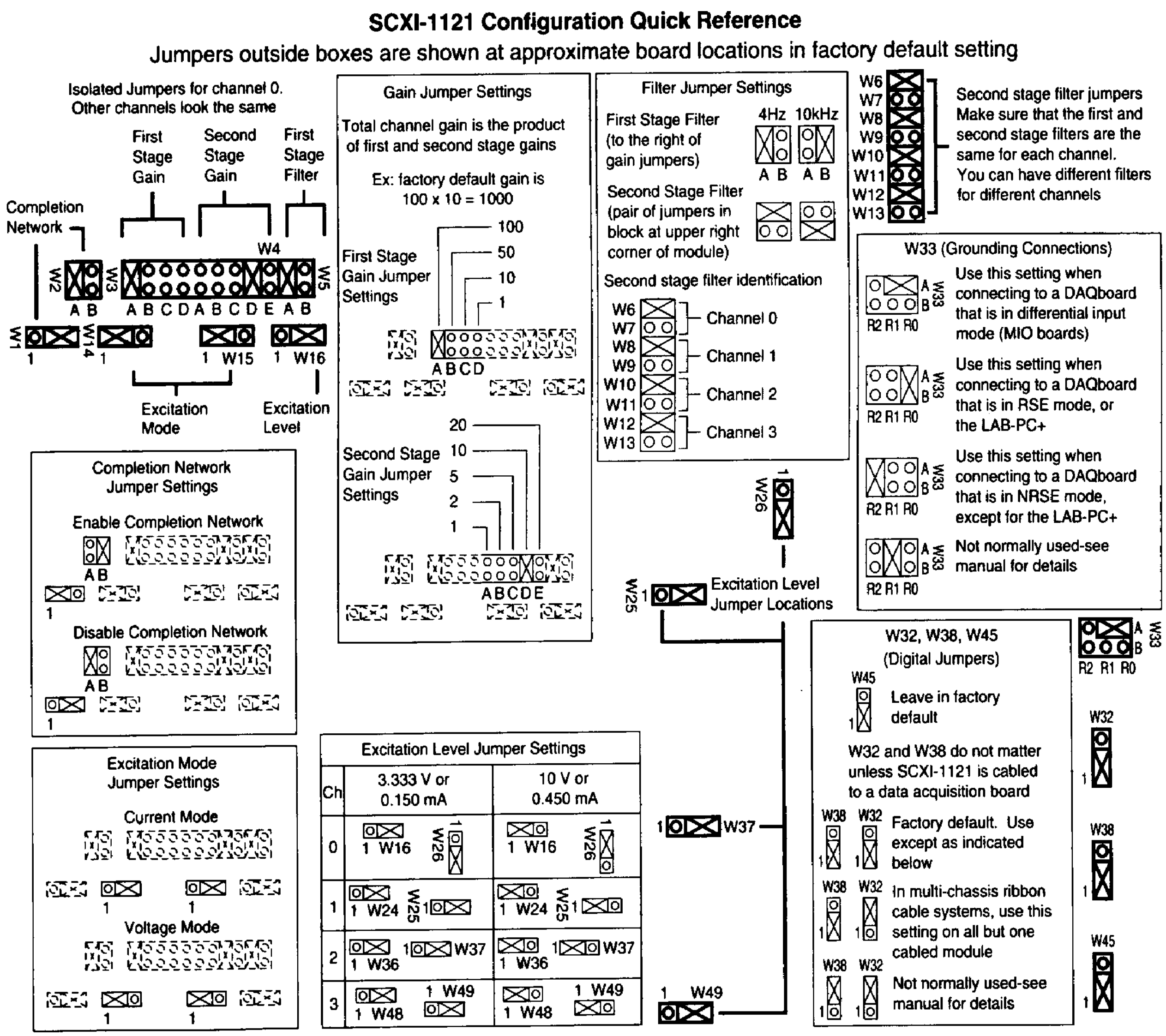


Figure 1.5. SCXI 1121.

Load Cell Calculations								
30000 pound load cell: **2.668** mV/Vex (from manufacturer's literature).								
Therefore, the output of the load cell is **26.68 mV** at 10 Volts excitation and 30000 pounds.								
30000	pounds	=	**1124438**	**pounds/volt**		**(load cell calibration constant)**		
0.02668	volts							
Calculate the maximum measurable load at different SCXI gains.								
@ Gain=100				maximum signal voltage				
	1124438	lbs/volt	*	5	volts	=	56222	pounds
	100							
		SCXI Gain		maximum measurable load				
Table 1		100			56222	pounds		
		200			28111	pounds		
		500			11244	pounds		
		1000			5622	pounds		
Strain Gage Calculations								
(All calculations for single active element configurations, 3.333 Volts excitation)								
V=(Vex*GF*strain)/4=(Vex*GF*e)/4			V=signal voltage , GF=gage factor , Vex=excitation voltage , e=strain					
μe/V=4/(GF*3.333e-6)=1200120.0/GF microstrain/Volt								
		Gage Factor		calibration constant		These values are entered		
Table 2		2.00		**600060**	μe/V	in the C(x-D) column of		
		2.01		**597075**	μe/V	the channel setup.		
		2.02		**594119**	μe/V			
		2.03		**591192**	μe/V			
		2.04		**588294**	μe/V			
		2.05		**585424**	μe/V			
		2.06		**582583**	μe/V			
		2.07		**579768**	μe/V			
		2.08		**576981**	μe/V			
		2.09		**574220**	μe/V			
		2.10		**571486**	μe/V			
Calculate the maximum measurable strains at different SCXI gains.								
@ Gain=200,GF=2.02				maximum signal voltage				
	594118.8119	μe/V	*	5	volts	=	14853	μe
	200							
		@ GF=2.1 (worst case..., use this table for all gage factors less than 2.1)						
Table 3		SCXI Gain		maximum measurable microstrain				
		50			57149			
		100			28574			
		200			14287			
		500			5715			
		1000			2857			

Figure 1.6. Calibration constant calculations and look-up tables.

1.2 Fatigue Test

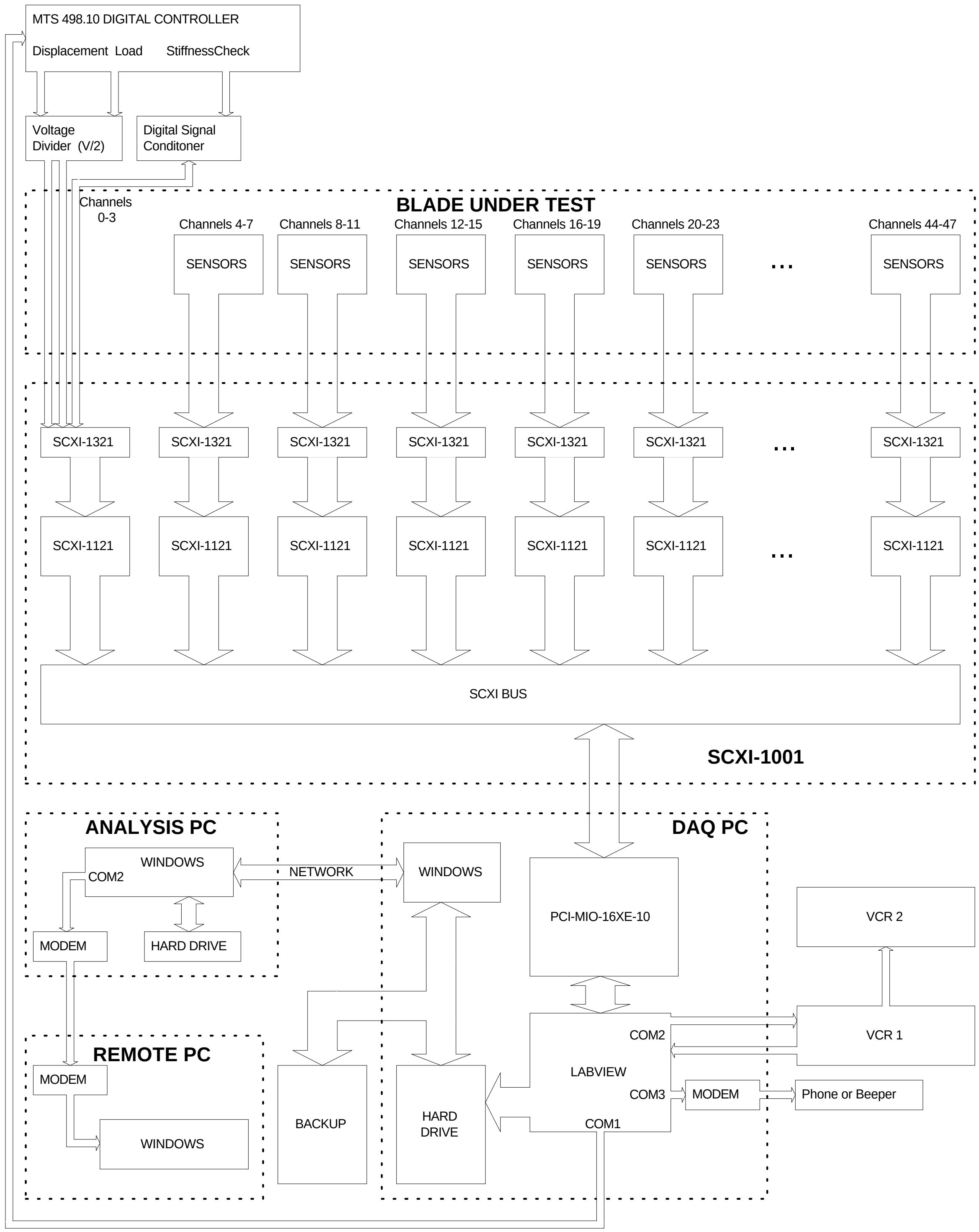


Figure 1.7. Signal block diagram for a fatigue test using the MTS 498.

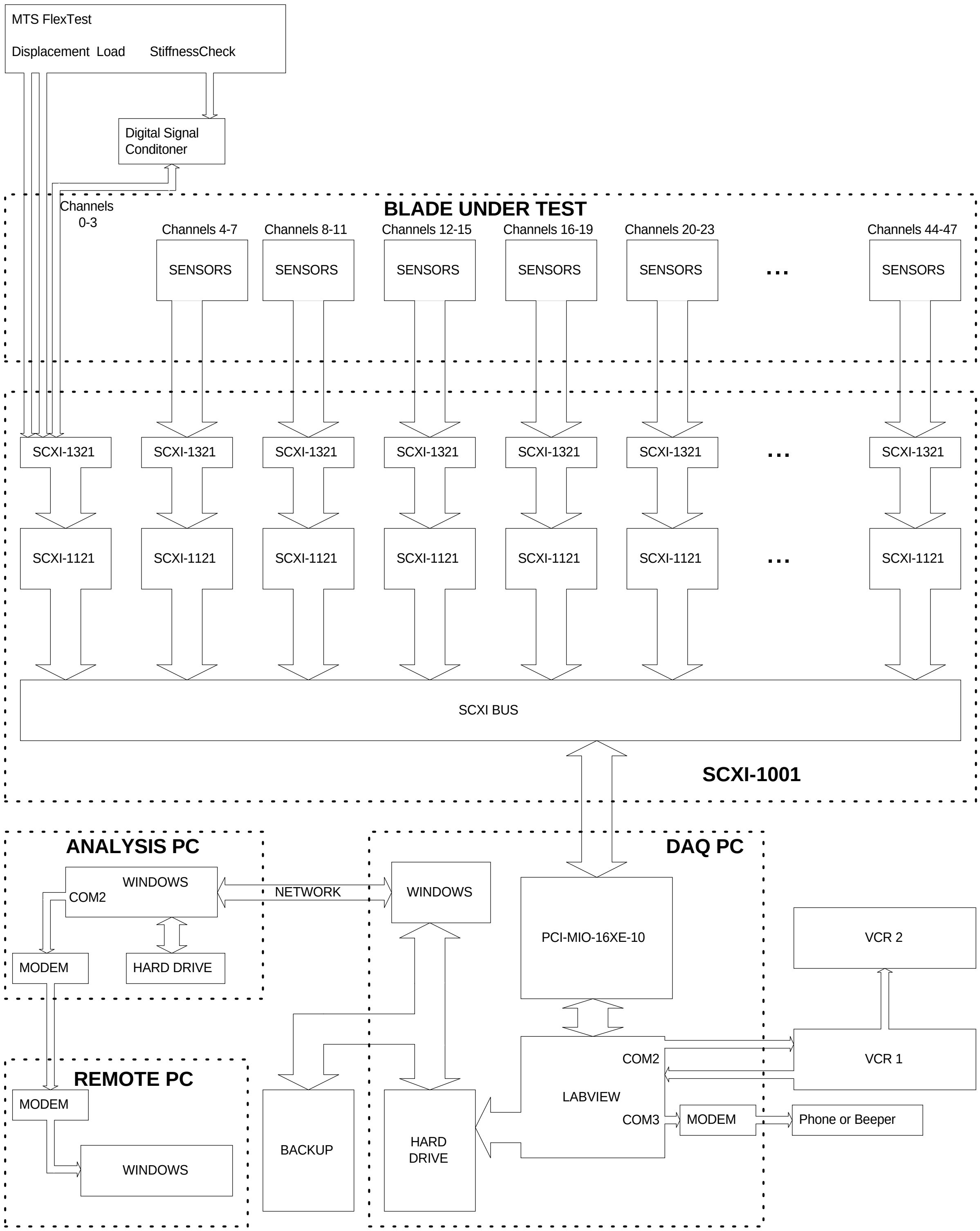


Figure 1.8. Signal block diagram for a fatigue test using the MTS FlexTest (single-axis).

The connections for a fatigue test are shown in Fig. 1.7 or 1.8 depending on the hydraulic control system being used (MTS 498/ TRAC or MTS FlexTest). The setup is similar to a static test except channels 0,1, and 2 are used for the load cell, lvdt, and stiffness check signal respectively, and channel 3 is not used at all. Channels 4-47 are still used for strain gages, except during a two-axis test where channels 4 and 5 are used for edge displacement and load. The first channel is used as the master channel in this test, and dictates the peak/valley detection algorithm, therefore, it should be a good signal (the displacement is usually the controlled signal with the MTS 458 / TRAC or FlexTest equipment and provides an almost perfect sinusoid).

The jumpers on the SCXI 1121 for channels 0, 1, and 2, are all set to gain = 1 and excitation = 3.333 Volts, and should never need to be changed. The jumpers for strain gage channels are set similar to the static test using Figures 1.5 and 1.6, and once again the settings can generally be left at; completion network disabled, excitation mode voltage, excitation level 3.333V, gain = 200, and filter = 10kHz.

The input voltage range of the SCXI module is ±5 Volts, but the voltage of output signals from the MTS 458 is ±10 Volts, so a voltage divider must be used. The new MTS FlexTest system has adjustable gains and does not require the voltage divider.

1.2.1 Stiffness Check Signal

The stiffness check signal is a digital output on the MTS 458 or FlexTest. The digital output is essentially a switch. The digital signal conditioner box puts a voltage of 3.333 Volts across this switch, if it is closed, the resultant signal voltage is low (≈ .7 Volts), if it is open the voltage is high (≈ 3.333 V).

1.2.2 VCR Communication

The VCRs are controlled by connecting COM 2 (serial B) of the DAQ computer to the RS-232C IN connector of VCR 1 using a “straight through” serial cable. There are two sets of DIP switches on the RS-232C interface of each VCR, SW1 and SW2. They are set as follows (1=up=on, 0=down=off):

	SW1	SW2
VCR1	101101	000001
VCR2	101101	100001

Chapter Two

2. Software and Operation

2.1 Installation

2.1.1 Network Considerations

The first step of the software setup is to make sure the network is properly configured (only required if you wish to use BSTATUS as BSTRAIN will monitor and control a test without the network connection). The following is a list of drive letter definitions for the network (DAQ1 and analysis1 are in the high bay of building 251 or the IUF, DAQ2 and analysis2 are in A60):

If you are using the DAQ computer

c:	main hard drive	
d:	data hard drive	
n:	hard drive c on analysis computer	(\\ANALYSIS1\ANALYSIS1-C)

If you are using the Analysis computer

c:	hard drive	
k:	hard drive c on DAQ computer	(\\DAQ1\DAQ1-C)
l:	hard drive d on DAQ computer	(\\DAQ1\DAQ1-D)

From a remote computer

o:	hard drive c on DAQ1 computer	(\\DAQ1\DAQ1-C)
p:	hard drive d on DAQ1 computer	(\\DAQ1\DAQ1-D)
t:	**hard drive c on analysis1 computer**	**(\\ANALYSIS1\ANALYSIS1-C)**
r:	hard drive c on DAQ2 computer	(\\DAQ2\DAQ2-C)
s:	hard drive d on DAQ2 computer	(\\DAQ2\DAQ2-D)
y:	**hard drive c on analysis2 computer**	**(\\ANALYSIS2\ANALYSIS2-C)**

If you reboot one machine when the other is not logged onto the network, you will get a warning that ‘network drive ##### could not be reconnected’, choose “OK” or if you are asked whether to reconnect drive in future choose “yes”.

When you reboot the analysis or DAQ computers, they prompt you for a login and password. The login is either daq or analysis and the password can be found in Appendix H.

2.1.2 Remote Access

If you have a modem and Windows for Workgroups, Windows 95, or Windows NT, you can access the network and retrieve a status file. In order to have the current test's status file written on the network drive, you need to make sure you have selected "write data to analysis computer" in the fatigue test general setup During a fatigue test, the data acquisition program writes the status file (*.sts) to the c:\fatigue directory on the analysis machine and updates it every 5 iterations (the program iterates once every 100 scans, so if you are scanning at 100Hz the status file will be written every 5 seconds). The BSTATUS software consists of one disk.

A. Windows 95 Setup

The following is a procedure to help you set up Dial-Up Networking (DUN) and BSTATUS. Setting up DUN seems to vary from computer to computer, depending on what is already installed on a given machine, but keep in mind that you are attempting to connect to a NetBEUI network running on Windows 95.

1) Start>programs>accessories>dial-up networking (this means hit the "start" button at the bottom left, then hit "programs", then hit "accessories", then select "dial-up networking"). If dial-up networking is not an option, you will need to install it in windows setup.

2) When asked "type a name for the computer you are dialing" enter **251 HIGHBAY**.

3) Hit "next".

4) Telephone #: **3033847003.**

5) "Next".

6) "Finish".

7) Select "make new connection".

8) **A60.**

9) **3033847010.**

10) Select "make new connection".

11) **IUF HIGHBAY.**

12) **3033847108.**

13) Right-click on each connection icon in DUN, and make sure the "properties" are as follows:

-general tab: check phone number and password,

-server types tab: type of server: PPP…,

advanced options all checked,

allowed protocols all checked.

14) Close DUN and open the "control panel"

15) Click on "network" and check the following:

-configuration tab => <u>things that should be installed:</u>

client for microsoft networks,

dial-up adapter,

IPX/SPX -> dial-up adapter (from microsoft),

NetBEUI -> dial-up adapter (from microsoft),

TCP/IP -> dial-up adapter (from microsoft),

file and printer sharing for microsoft networks,

Primary Network Logon:

client for microsoft networks.

16) Start>shutdown>"restart the computer".

17) After restarting, double-click on "my computer".

18) Double-click on "dial-up networking".

19) (Optional) Create a shortcut icon by hitting the right mouse button on the each icon and selecting "create shortcut icon". Drag shortcut icons onto the desktop.

20) Double-click on IUF HIGHBAY or 251 HIGHBAY.

user name: **yourfirstname**

password: **bstrain**

hit "connect"

21) Once you have established a connection, continue to step 22.

22) Start>programs>windows explorer.

23) Under "tools", select map network drive

-drive: **t:**

-path: **\\analysis1\analysis1-c**

-make sure "reconnect at logon (startup)" is checked

-"OK".

24) "Disconnect".

25) Logon to A60.

26) Under "tools", select map network drive

-drive: **y:**

-path: **\\analysis2\analysis2-c**

-make sure "reconnect at logon (startup)" is checked

-"OK".

27) "Disconnect".

28) Close explorer.

29) Place BSTATUS disk 1 in drive a: .

30) Start>run>"a:setup", follow instructions.

31) Make a shortcut to BSTATUS if you like.

B. To Start BSTATUS

BSTATUS automatically transmits test status information to your computer and displays it on the screen. Remember that if you want to use BSTATUS, you need to make sure you have selected "write data to analysis computer" in the fatigue test general setup. Before starting BSTATUS you must login to 251 HIGHBAY, A60, or IUF HIGHBAY. In Win95 you double-click on one of the shortcut icons you made, or go into the dial-up networking menu. Once you are logged on to the network you just double-click on the BSTATUS icon. This will bring up the screen shown in Figure 2.1.

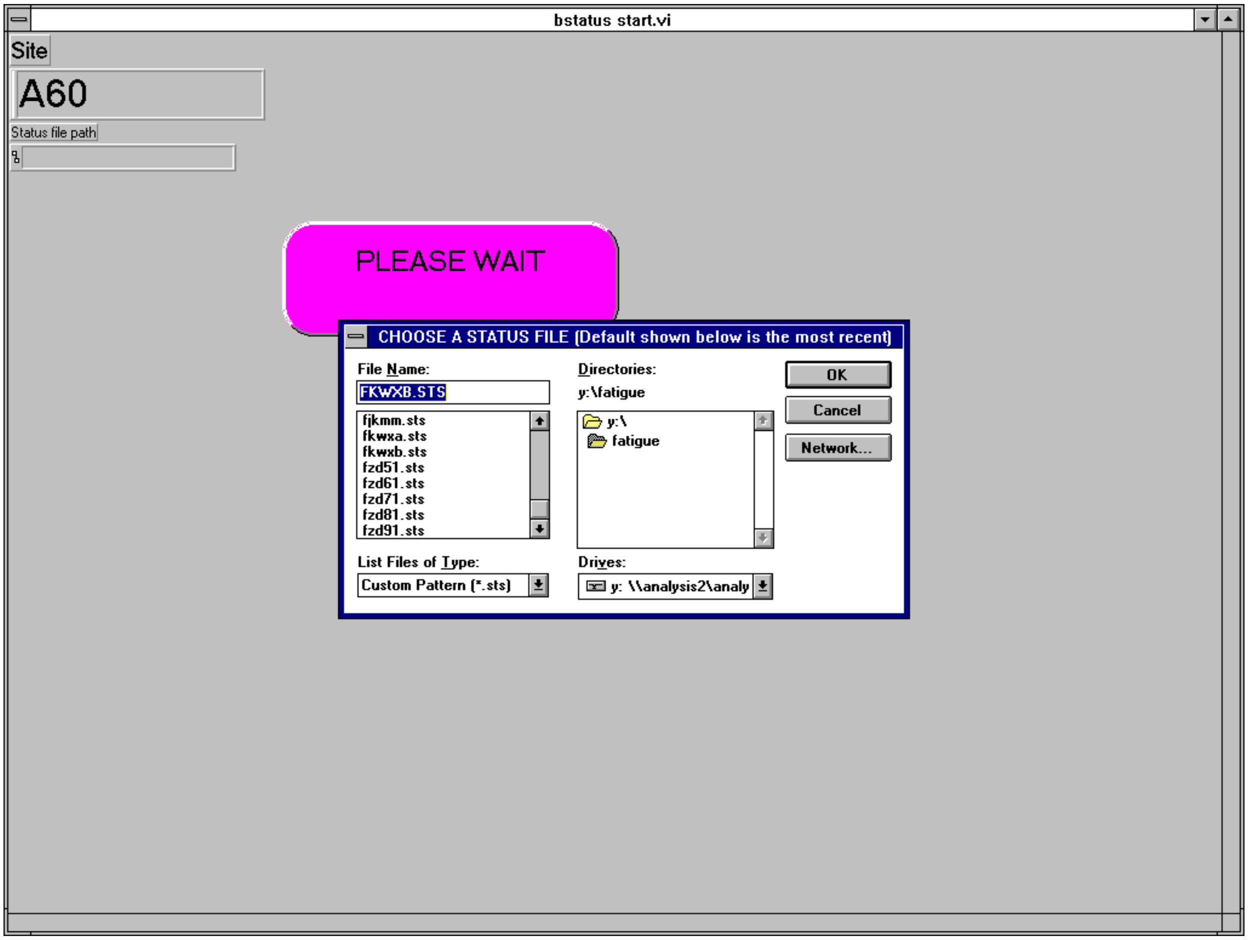


Figure 2.1. BSTATUS startup window.

When this screen first comes up, the program searches for drive t: or y:. It then determines if you are connected to A60 or one of the HIGHBAYs, and searches the fatigue directory on that drive for the most recent status file. In Fig. 2.1, "FJK13.STS" was found to be the most recent status file in A60 and is presented as the default selection. After you select a file the program brings up it's main window, shown in Fig. 2.2. The window shown in this case is for a system with 1024 by 768 video resolution. If you have a different resolution you can select it using the screen size control, to optimize your status display. Each time this program updates the screen, it copies the status file to your local hard drive in a directory called

c:\bstrain. Pressing the “PRINT THIS SCREEN” control, sends the status information to your default printer.

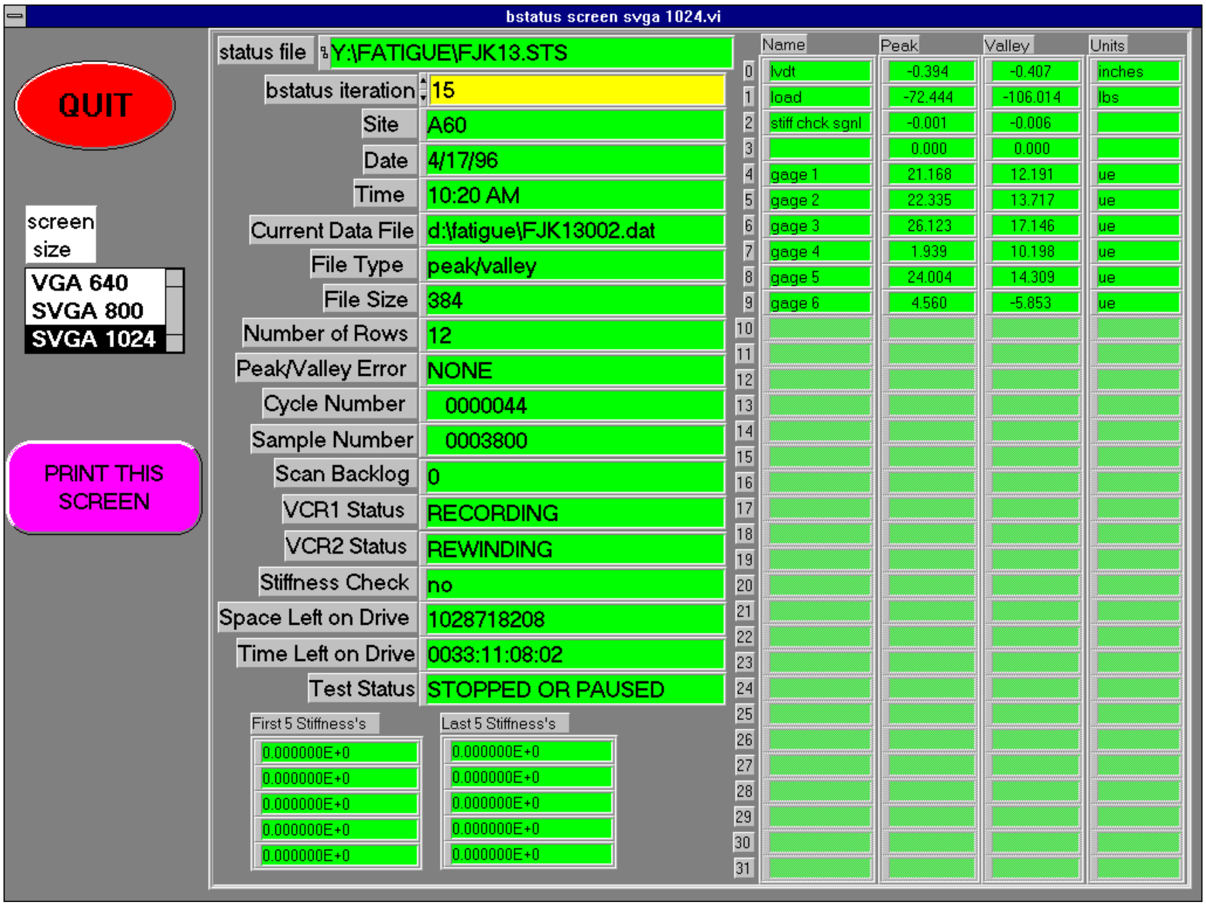


Figure 2.2. Main BSTATUS window.

2.1.3 BSTRAIN Setup

In order to use BSTRAIN you need to first copy all files from the BSTRAIN floppy disks to the directory **c:\bstrain**. Next, create a BSTRAIN "program group" by selecting "new" under the file menu in program manager. To create the BSTRAIN icon, use the following procedure:

1) open the program group "BSTRAIN" which you just created and make sure it is highlighted

2) from the file menu of program manager, select new

3) select "program item"

4) description: **BSTRAIN**

5) command line: **c:\bstrain\bstrain.exe**

6) working directory: **c:\bstrain**

7) select "change icon"

8) where it says "file name" type: **c:\bstrain\bstrain.ico**

9) press "OK" and you should see the BSTRAIN icon

10) press "OK" a couple more times to finish

To start BSTRAIN, double-click on the icon and you will see the initial screen shown in Fig. 2.3.

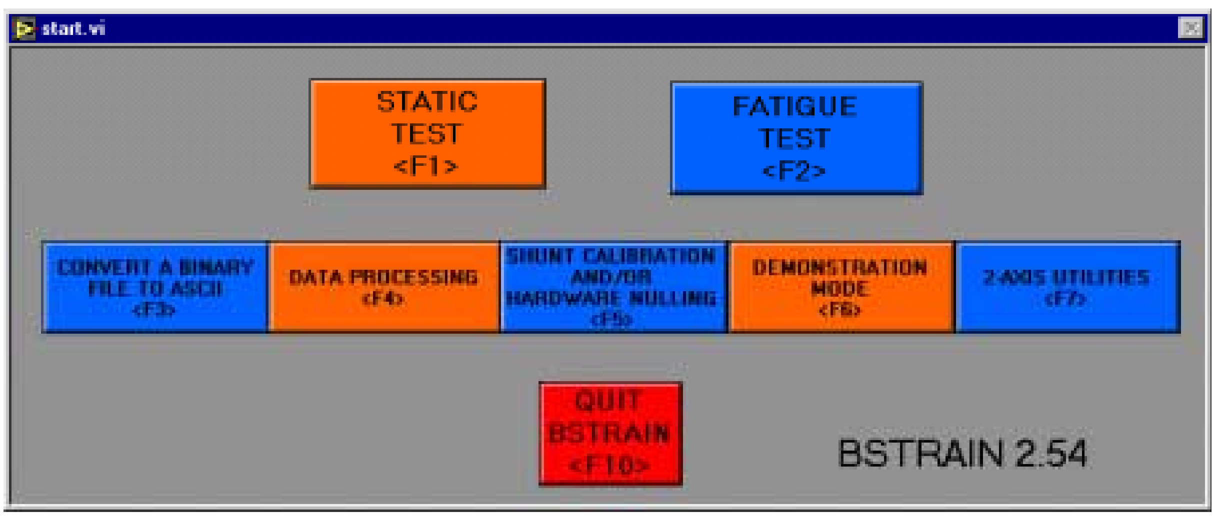


Figure 2.3. Initial window.

Click on one of the six buttons to start the desired function:

-STATIC TEST	-start or continue a static test
-FATIGUE TEST	-start or continue a fatigue test
-CONVERT A BINARY FILE TO ASCII	-convert a binary data file (*.dat) to a tab delimited ASCII file
-DATA PROCESSING	-generate a header file summary or autozero summary
-SHUNT CALIBRATION AND/OR HARDWARE NULLING	-acquires data but does not save it, useful for hardware nulling, also activates SCXI shunt cal
-DEMONSTRATION MODE	-start a demonstration static or fatigue test
-2-AXIS UTILITIES	-start the 2-axis calculator or 2ACD
-QUIT BSTRAIN	-quits BSTRAIN and exits LabVIEW

2.2 Static Test

During the static test, a blade is loaded slowly to some proof load or to its breaking point. Data is taken continuously from multiple strain gages and a load cell. The static test has a typical duration of one hour and a typical scan rate of 0.5 to 20 Hz.

2.2.1 Continue/New window

Fig. 2.4 shows the first window you see after selecting a static test. Choose "continue" if you want to restart a test which was stopped for any reason. The program will prompt you to select a *.old file. This file tells BSTRAIN all the information it needs to restart the test where it left off (cycle number, sample number, data file name, etc.).

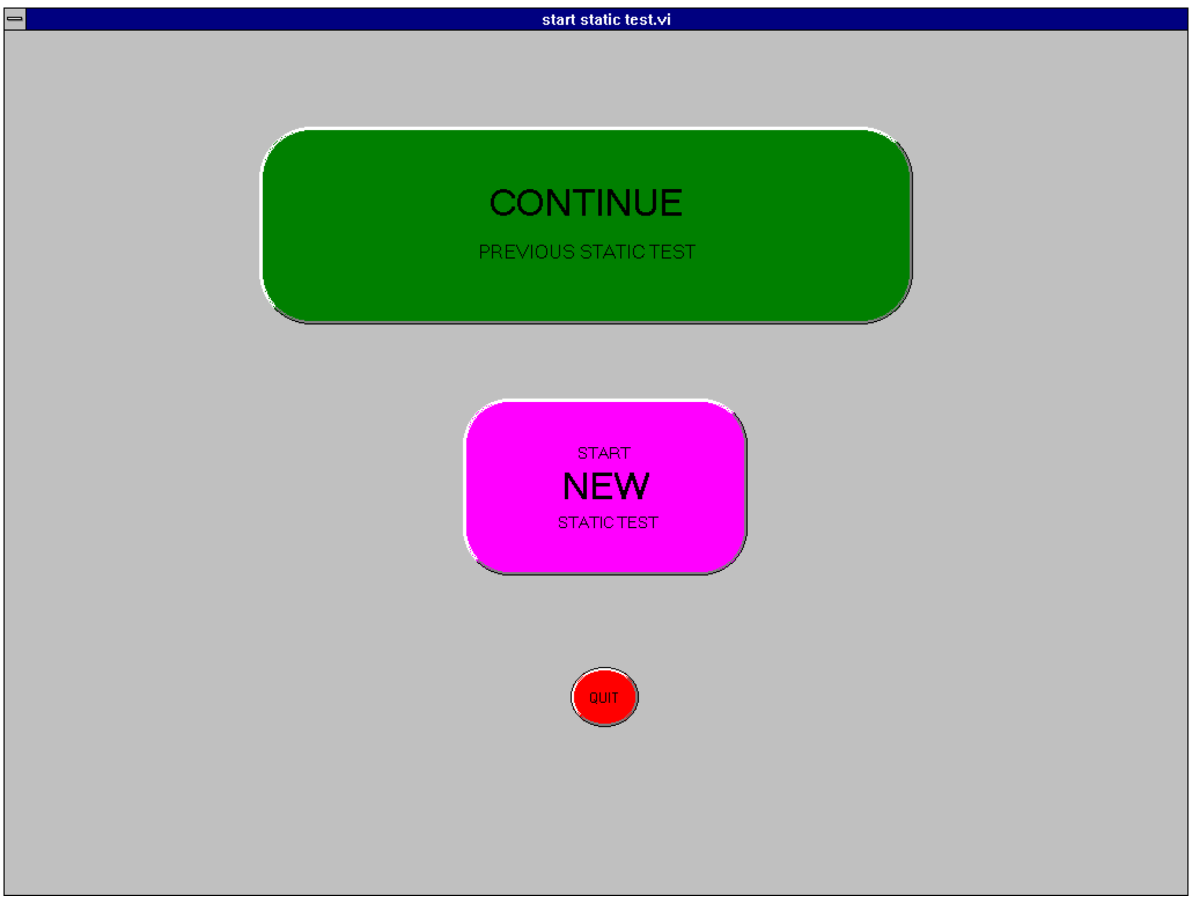


Figure 2.4. Static test start-up window.

Choose "new" if you do not want to continue a test specified by a *.old file. The program will take you through the following windows and write a new header file. Pressing "quit" returns you to the main BSTRAIN menu.

2.2.2 Create File Name Window

Fig. 2.5 shows the next window where you create the file name to be used in all files associated with this test. This same window is used for the static and fatigue tests. Simply choose the manufacturer you want to use and a two character test code and BSTRAIN will create a file name of the type S$$$$.

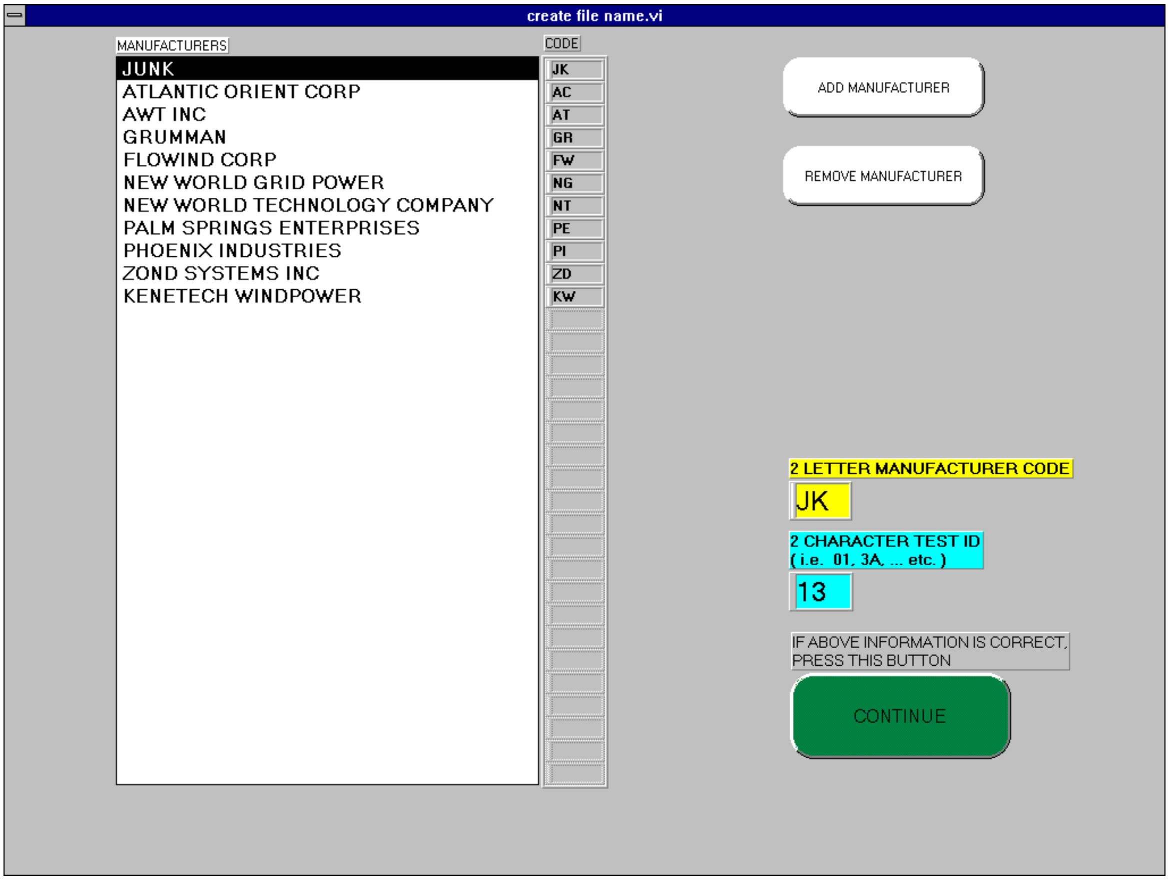


Figure 2.5. Test name setup window.

A. Add a Manufacturer

Allows you to add a manufacturer and corresponding code to the list.

B. Remove a Manufacturer

Allows you to remove an entry from the manufacturer list.

2.2.3 Static Test Setup Window

Once this window appears (Fig. 2.6), the program starts sampling the channel shown at the bottom left, “Load Cell Channel”, and based on its coefficients in the CHANNEL SETUP section it displays the value at “LOAD”. Simultaneously it sends this same value to the digital display on COM 1. This allows you to adjust the blade to zero conditions in order to zero the strain gages.

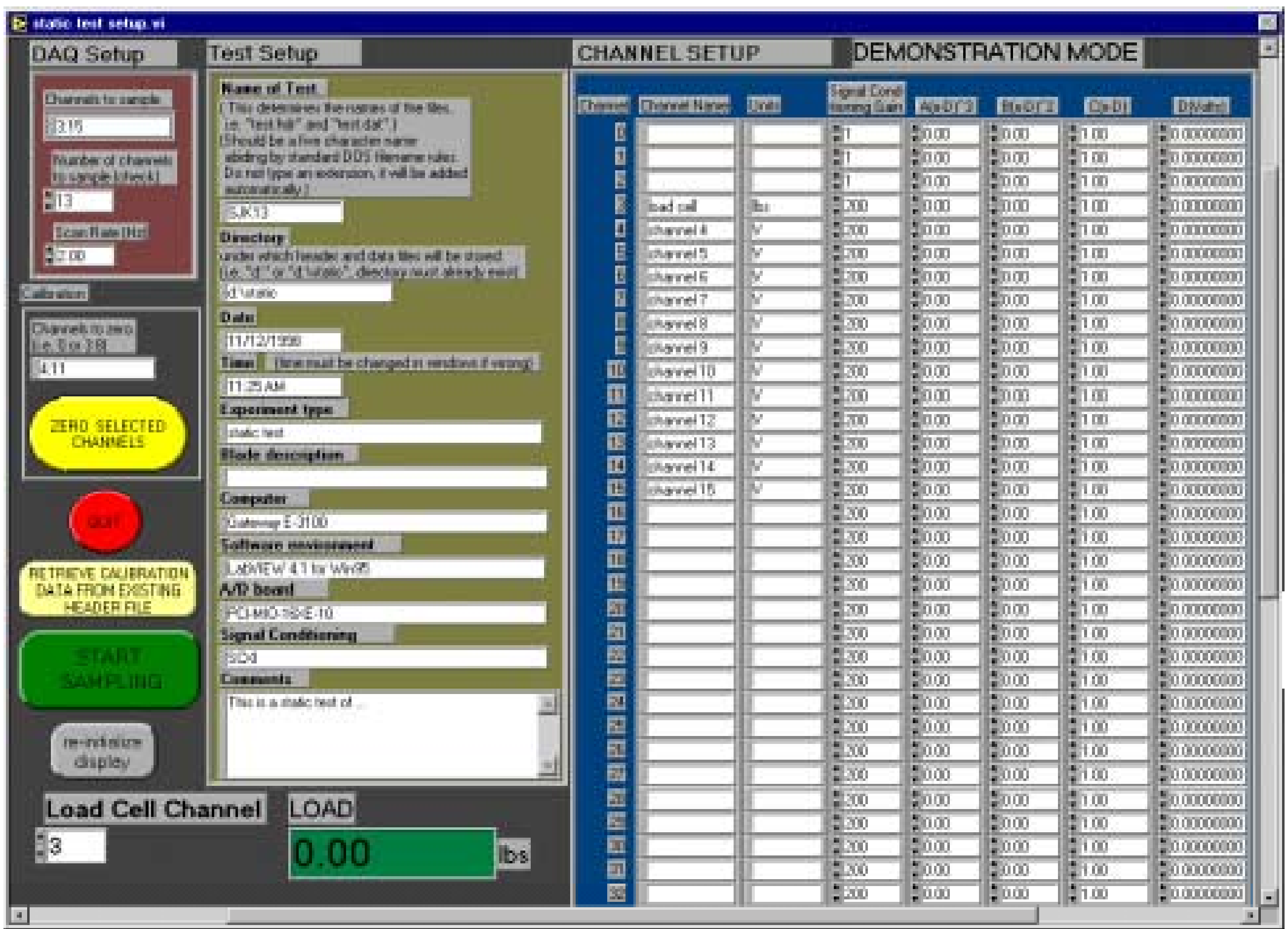


Figure 2.6. Main setup window for static test.

A. Retrieve Calibration Data From Existing Header File

This function prompts you to select a previous header file and reads in that information. Don’t enter information in the setup window and then hit this button, as it overwrites most of the cells on this screen.

B. DAQ Setup Cluster

Channels to Sample: Enter the range of channels you wish to sample separated by a colon (e.g., 3:15). For a static test this should be channel 3 through something.

Number of Channels: Just to make sure you are sampling what you think you are, enter the number of channels that the "channels to sample" string specifies (e.g., 3:15 would be 13 channels).

Scan Rate: Specify the scan rate. 0.5 to 20 Hz is typical. A scan is a sample of every channel specified. Individual channels are sampled one at a time, as quickly as possible (approximately 10µs between samples). So at 2Hz a description of the scanning process would be as follows: 1) the board samples each of the 13 channels with a 10µs delay between each sample for a total of about 120µs, 2) the board waits 499,880µs and then scans again.

C. Test Setup Cluster

Enter text in the various boxes which will be written to the header file. Do not use tabs or carriage returns (enter key).

Name of Test: Automatically generated from the create file name window (section 2.3.2), but you can change it here if you wish.

Directory: Default is "d:\static".

Date and Time: These are from the computer. If they are wrong, do not change them here, but in the Windows Control Panel.

Experiment Type: Default is "static".

Computer: Default is "Gateway E-3100". This is a 300MHz Pentium with 256Mb ram and two 4Gb hard drives.

Software Environment: Default is "LabVIEW 5.01 for Windows 95"

A/D Board: Default is "PCI-MIO-16XE-10". This is a 100kHz, 16 bit PCI bus A/D board from National Instruments.

Signal Conditioning: Default is "SCXI".

D. Channel Setup Cluster

Name and Units: Enter a name and units for each channel.

Gain: See section 1.1 for a description of the signal conditioning gain.

Scaling Factors: Enter the coefficients to convert the sensor voltage (x) to engineering units (see Fig. 1.6).

$$\text{Engineering units} = A(x\text{-}D)^3+B(x\text{-}D)^2+C(x\text{-}D)+D\ .$$

E. Load Cell Channel / Load

"Load Cell Channel" , in the lower left corner, specifies which channel's data is sent to "LOAD" and the digital display.

F. Re-initialize Display

The digital display is a large 8-digit LED unit which allows readings (i.e. load) to be seen by personnel in the crane bay (i.e. the crane operator). If the digital display loses power while BSTRAIN is active, the display needs to be re-initialized by hitting this button.

G. Calibration

When you press the “ZERO SELECTED CHANNELS” button, the program measures the offset voltage of the selected channels and enters it into the CHANNEL SETUP>D(Volts) array. This is a software zero. Perform this function with the test specimen at desired zero conditions.

H. Quit

Quits the static test and returns you the main BSTRAIN menu.

I. Start Sampling

Go to the run window and start sampling.

2.2.4 Static Test Run Window

Fig. 2.7 shows the main static test window. Sampled data will be displayed on the strip chart and channel listing in real-time. The first thing you should do when this screen comes up, is look at the **white** controls. These are controls which accept user input. The following text is a explanation of the controls, first, and then the indicators in this window.

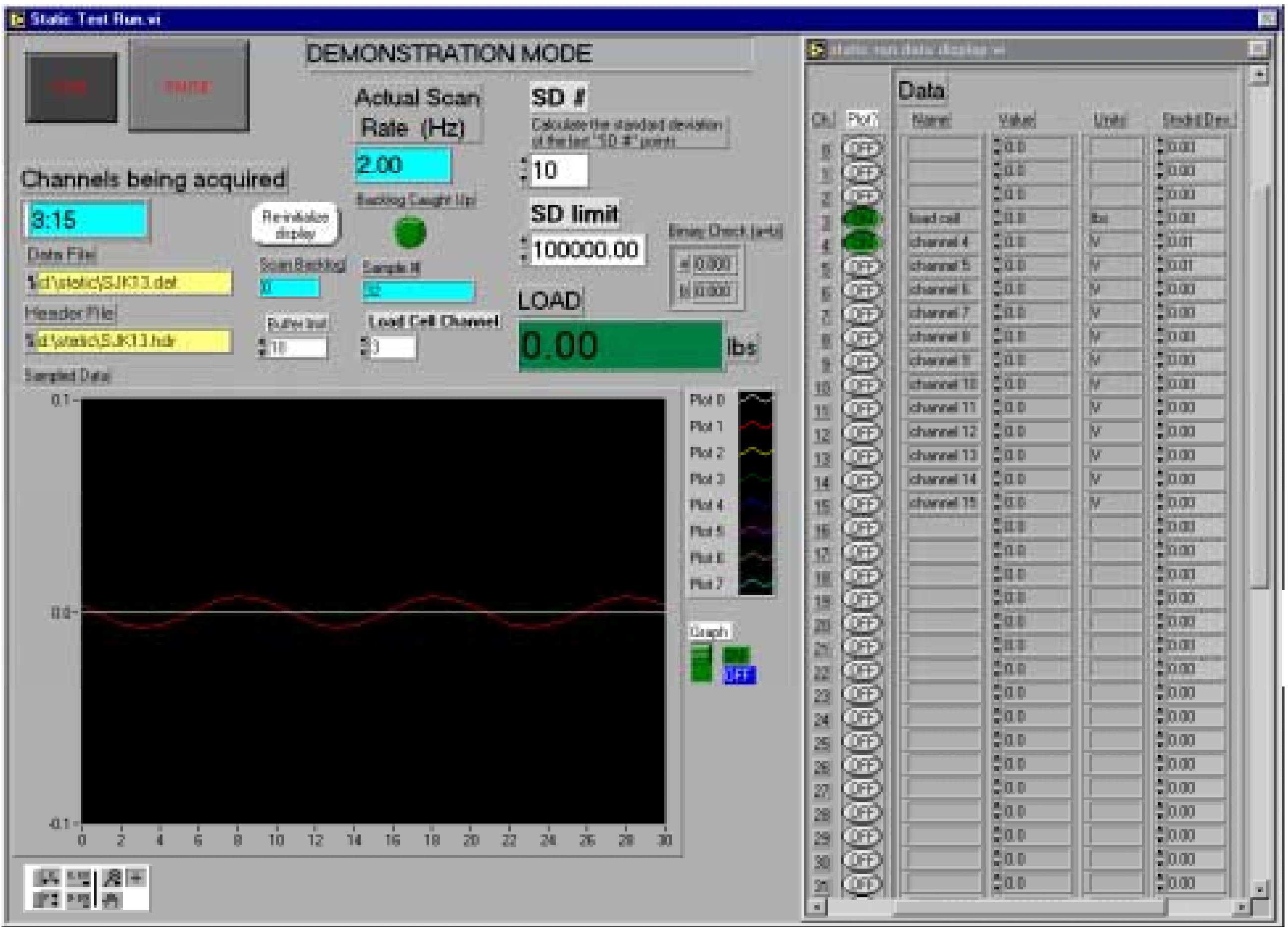


Figure 2.7. Main static test window

A. Plot?

Turn on each channel you want to chart by clicking on it.

B. Buffer Limit

This is a limit for the number of scans in the backlog buffer (scans which have been sampled by the A/D, but have not yet been processed by BSTRAIN). If the Scan Backlog goes over this limit, BSTRAIN shuts down some extraneous features (such as the chart), and attempts to catch up. If you are sampling at 2 Hz and the Scan Backlog is 10 scans, it means that the data you are looking at is 5 seconds old. If the Scan Backlog buffer goes over 50,000 scans, the program will quit.

C. Load Cell Channel / Load

Select the channel whose value you wish to send to the digital display and to the indicator “LOAD”.

D. SD

Specifies the number of consecutive samples BSTRAIN uses to calculate the standard deviation of each channel. For example, an input of 10 instructs BSTRAIN to calculate the standard deviation based on the last 10 samples.

E. SD Limit

If the standard deviation of any channel goes over the value set here, the Standard Dev. column will turn red. This feature can be used to detect instabilities.

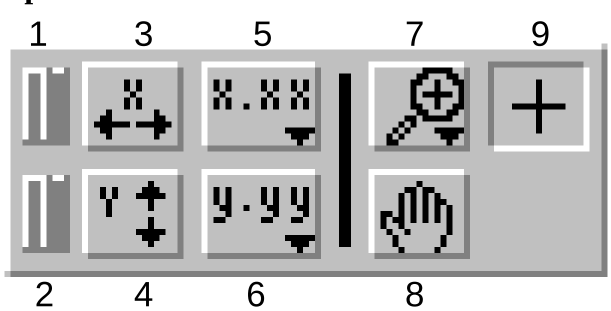
F. Re-initialize Display

The digital display is a large 8-digit LED unit which allows readings (i.e. load) to be seen by personnel in the crane bay (i.e. the crane operator). If the digital display loses power while BSTRAIN is active, the display needs to be re-initialized by hitting this button.

G. Graph

Turns the chart on and off.

H. Graph Control Icons



Button 3) Pressing this button autoscales the x-axis.

Button 4) Pressing this button autoscales the y-axis.

Buttons 1&2) When you press either of these buttons it locks button 3 or 4 in the on (autoscale) position.

Buttons 5&6) Miscellaneous graph formatting options.

Button 7) Zooming tool. Press this button to see different options for zooming.

Button 8) Grabbing tool. Just try it.

Button 9) Cursor tool. Not used.

I. Channels Being Acquired

Tells you which channels are currently being sampled and written to the *.dat file.

J. Data File

Path and name of the current data file being collected.

K. Header File

Path and name of the current header file.

L. Actual Scan Rate (Hz)

Value returned by the A/D board specifying the scan rate in Hertz.

M. Backlog Caught Up

Normally green. Sticks out and turns red if the program is attempting to process all scans in the backlog.

N. Sample

Number of scans the program has made.

O. Data

Names, Values, Units and Standard Deviations for all channels.

P. Pause

When this button is depressed the program pauses data collection, instead of writing it to disk. Data collection will be resumed when this button is hit again.

Q. Stop

Stops acquisition, closes the data file and exits the static test. Any backlogged data will be lost.

2.3 Fatigue Test

During the fatigue test, a blade is repeatedly subjected to a specified load history. Data can be taken from multiple strain gages, a load cell, a displacement transducer and a digital output from the MTS equipment. The fatigue test has a typical duration of one month and a typical scan rate of 60Hz. The data acquisition system provides capabilities for automated stiffness checks, automated zeroing, peak valley detection, data decimation and VCR control.

2.3.1 Continue/New Window

Fig. 2.8 shows the first window you see after selecting a fatigue test. Choose "continue" if you want to restart a test which was stopped for any reason. The program will prompt you to select a *.old file. This file tells BSTRAIN all the information it needs to restart the test where it left off (cycle number, sample number, data file number, etc.).

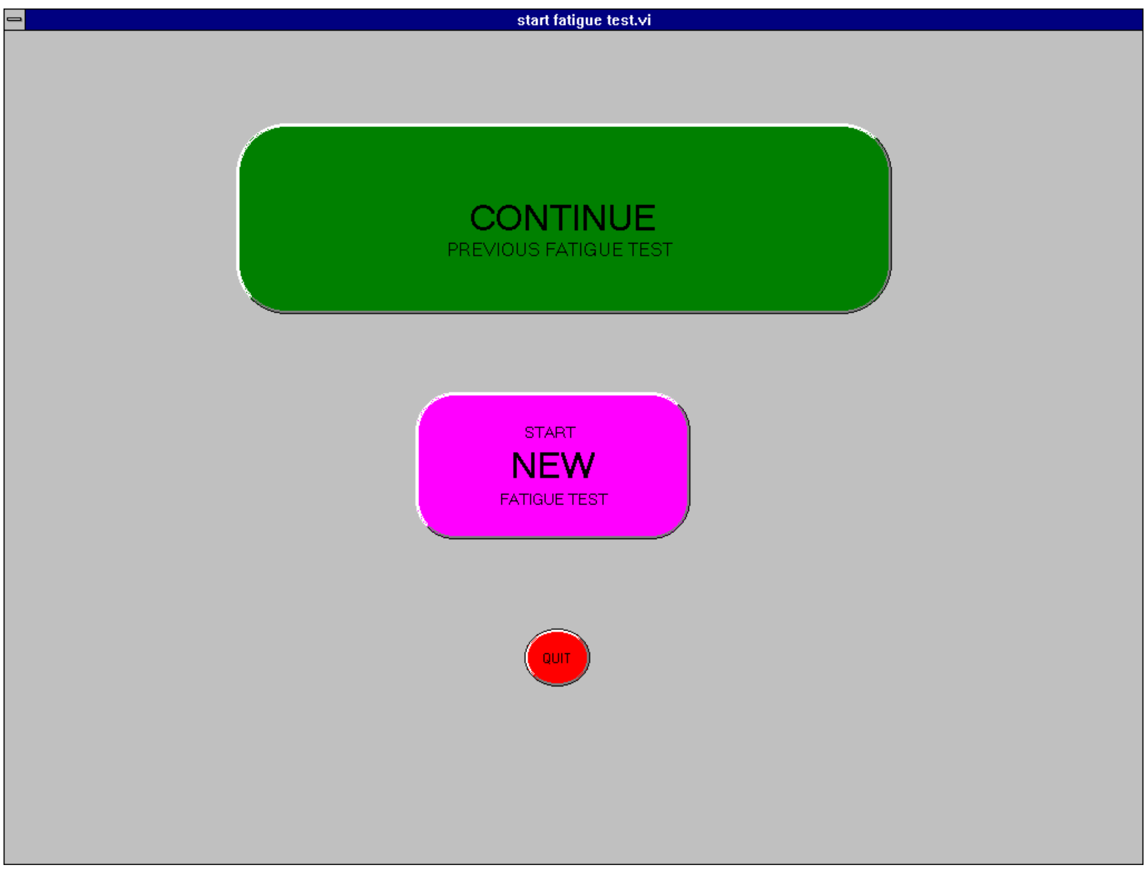


Figure 2.8. Fatigue test start-up window.

Choose "new" if you do not want to continue a test specified by a *.old file. The program will take you to the create file name window (Fig. 2.5) and then through the following windows, writing a new header file when you start acquiring data.

2.3.2 Fatigue Test Setup Window

The values you enter in this section tell BSTRAIN how to acquire data, how to convert signals to engineering units, and general information about the test which will be written in the header file. Channels can also be software zeroed in this window.

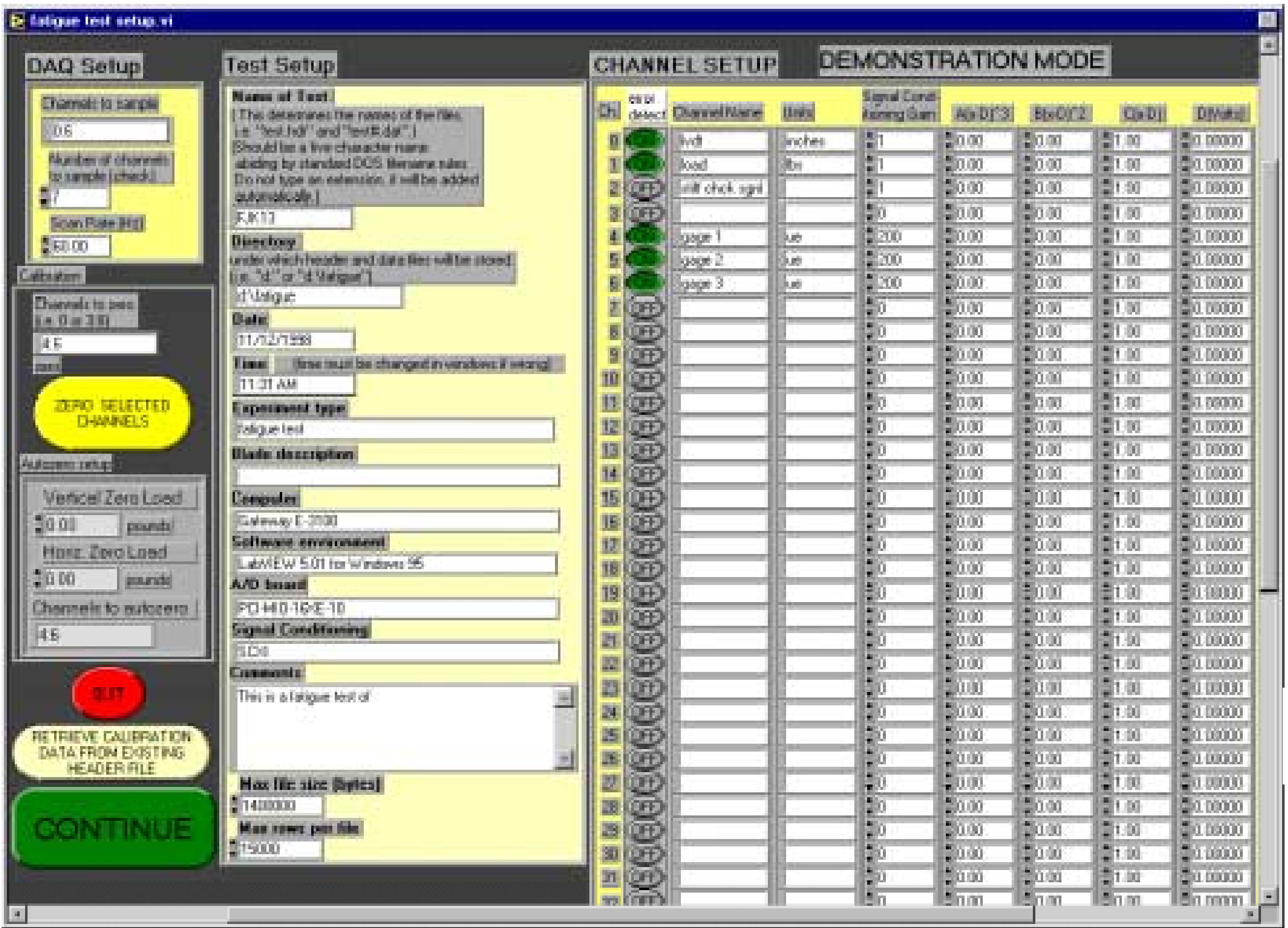


Figure 2.9. Main setup window for fatigue test.

A. Retrieve Calibration Data From Existing Header File

This function allows you to select a previous header file and read in that information. Don't enter information in the setup window and then hit this button, as it overwrites most of the cells on this screen.

B. DAQ Setup Cluster

Channels to Sample: Enter the range of channels you wish to sample separated by a colon (e.g., 0:17). For a fatigue test this should be channel 0 through something (channel 3 will be sampled but should be ignored as it is reserved for a static test).

Number of Channels: Just to make sure you are sampling what you think you are, enter the number of channels that the "channels to sample" string specifies (e.g., 0:17 would be 18 channels).

Scan Rate: Specify the scan rate. 100Hz is typical for fatigue tests with frequencies in the range of 1Hz. A scan is a sample of every channel specified. Individual channels are sampled one at a time, as quickly as possible (approximately 10μs between samples). So at 100Hz with channels 0:17, a description of the scanning process would be as follows: 1) the board samples each of the 18 channels with a 10μs delay between each sample for a total of about 170μs, 2) the board waits about 9830 μs and then scans again.

C. Test Setup Cluster

Enter text in the various boxes which will be written to the header file. Do not use tabs or carriage returns (enter key).

Name of Test: Automatically generated from the create file name window (section 2.3.2), but you can change it here if you wish.

Directory: Default is “d:\fatigue”.

Date and Time: These are from the computer. If they are wrong, change them in Windows.

Experiment Type: Default is “fatigue”.

Computer: Default is “Gateway E-3100”. This is a 300MHz Pentium II with 256Mb ram and two 4Gb hard drives.

Software Environment: Default is “LabVIEW 5.01 for Windows 95”

A/D Board: Default is “PCI-MIO-16XE-10”. This is a 100kHz, 16 bit PCI bus A/D board from National Instruments.

Signal Conditioning: Default is “SCXI”.

Max File Size [bytes]: Specify the maximum number of bytes to write to a data file. Setting this to about 1,400,000 ensures that data files will fit on a 1.44Mb floppy disk.

Max Rows Per File: Specify the maximum number of rows to write to a data file. Setting this to about 15000 ensures that the data will fit into Microsoft Excel.

D. Channel Setup Cluster

Name and Units: Enter a name and units for each channel.

Gain: See section 1.2 for a description of the signal conditioning gain.

Scaling Factors: Enter the coefficients to convert the sensor voltage (x) to engineering units (see Fig. 1.6).

$$\text{Engineering units} = A(x-D)^3+B(x-D)^2+C(x-D)+D\ .$$

E. Calibration

When you press the “ZERO SELECTED CHANNELS” button, the program measures the offset voltage of the selected channels and enters it into the CHANNEL SETUP>D(Volts) array. When the raw data is converted to engineering units, the voltages in the D(Volts) array are subtracted from the signal voltage of their respective channel. This is a software zero. Perform this function with the test specimen at desired zero conditions.

F. Autozero Setup

Autozero also performs a software zero, as described above in Calibration, but it does it automatically during stiffness checks throughout the test (see description of algorithm in section 2.4.3.2).

Zero Loads: During a stiffness check, BSTRAIN will attempt to measure zeroes at these loads.

Channels to Autozero: Specify the channel or channels to autozero.

G. Quit

Quits the fatigue test, returning to the main BSTRAIN menu. Does not save any changes you have made so far.

H. Continue

Go to the stiffness check and peak/valley detection setup window.

2.3.3 Stiffness Check and Peak/Valley Detection Setup Window

2.3.3.1 Stiffness Check Algorithm

Fig. 2.10 shows the window where you enter values to help the program do stiffness checks and find peaks and valleys. The stiffness check algorithm performs the following functions.

1) continuously checks raw data to see if the stiffness check signal goes high (greater than 13100 binary bits or 2 Volts),

2) when the signal has been set high (by the MTS controller),

-it finds the first valley with a sample # which is at least 10% of a cycle higher than where the stiffness check started,

-finds the next valley (BSTRAIN now has 1 cycle of stiffness check data),

-for a two-axis test, calculates the actual horizontal and vertical waveforms,

-finds the maximum and minimum loads and displacements for the cycle and calculates the stiffness (vertical and horizontal stiffness for a two-axis test).

The operator must set-up the MTS hydraulic controller to perform this stiffness check (or use the block profiles created by 2ACD in a 2-axis test). Based on the above algorithm, you can see that, depending on where you start the stiffness check, it should last **at least three cycles**. In practice, we have found it convenient to start and end the stiffness check at valleys, but this should not be required. Also note that in order to do a stiffness check, the algorithm only needs to detect a high stiffness check signal once, but for peak/valley detection to work properly **the signal must be high during the whole stiffness check**. To set the signal high with the MTS equipment, you should have a command which **clears [C]** the digital output (setting [S] the digital output shorts the voltage source and creates a low signal). Fig. 2.11 shows example stiffness check waveforms for the case where the stiffness check was started and stopped at the midpoint of the sine wave.

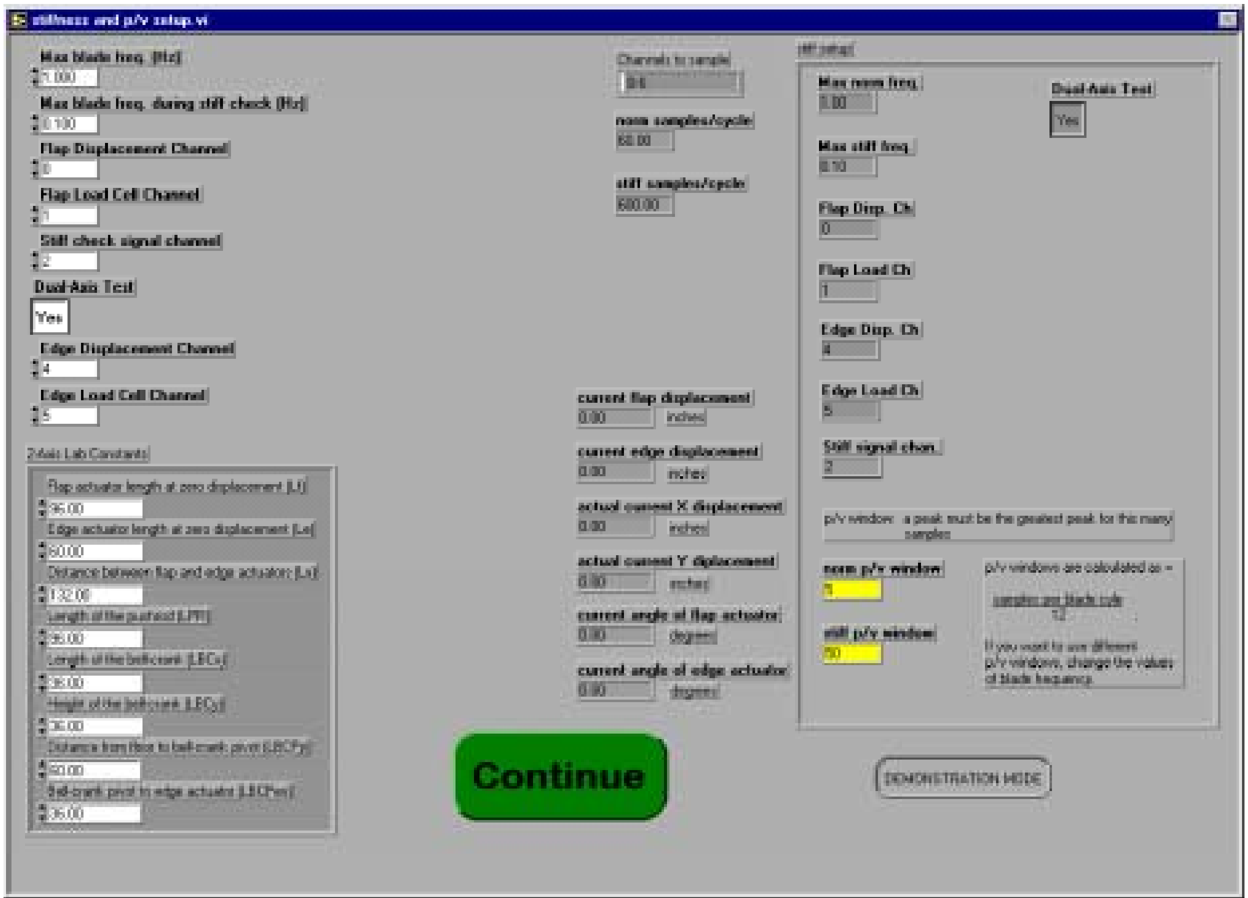


Figure 2.10. Stiffness check and peak/valley detection setup window.

A. Max Blade Freq. [Hz]

Enter the blade frequency of normal test operation.

B. Max Blade Freq. During Stiff Check [Hz]

Enter the blade frequency during a stiffness check.

C. Flap & Edge Channels, Stiff Check Signal Channel

Enter the respective channel numbers. 0,1,2,4, and 5 are normal.

D. Stiff Setup

This box displays the values which will be sent on to the main program. The p/v windows are calculated as the number of samples per blade cycle divided by 12.

E. 2-Axis values

If a 2-axis test is specified, enter the lab constants. The calculated current values are displayed to the right.

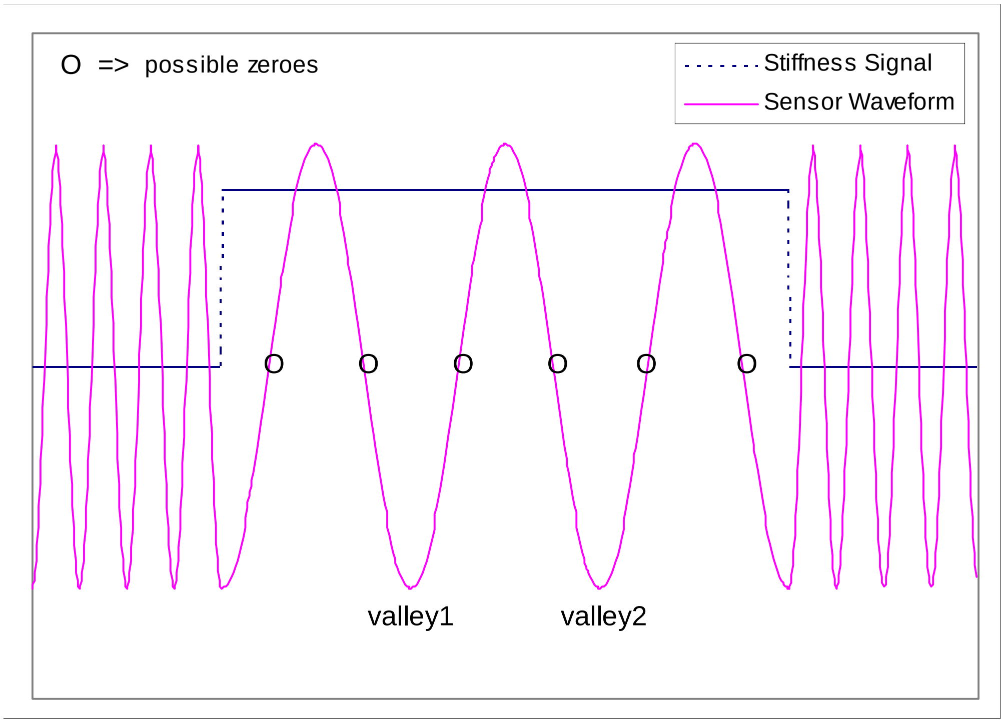


Figure 2.11. Typical waveforms during a stiffness check for a 1-axis test.

2.3.3.2 Autozero Algorithm

The algorithm for autozero is straightforward as follows:

1) detect stiffness check (signal greater than 2.0 Volts),

2) wait a quarter cycle (derived from the specified stiffness check blade frequency),

3) read any and all zeroes (data corresponding to a load which differs from the “Zero Load” by less than 0.1% of full scale, in a two-axis test both loads must meet the criteria at the same time), if no zeroes are found then the zeroes are not changed,

4) look for the end of the stiffness check (signal less 2.0 Volts),

5) average zeroes for each channel,

6) write each channel’s zeroes to *.zro file and update the D(volts) scaling constant so that new zeroes are accurately represented on the graph, later, when raw data (*.dat file) is converted to engineering units the *.zro file will be checked to see if it has a more recent zero than the header file.

2.3.3.3 Peak / Valley Detection Algorithm

The peak/valley detection algorithm can be described as follows:

1) First find master peaks. Master peaks are where the first channel (usually displacement) has a peak which is the greatest peak for plus/minus 1/12 of a cycle.

2) Take the data between two master peaks (one cycle of data) and find the maximum and minimum of each channel.

2.3.4 Cycle Count Adjustment Window

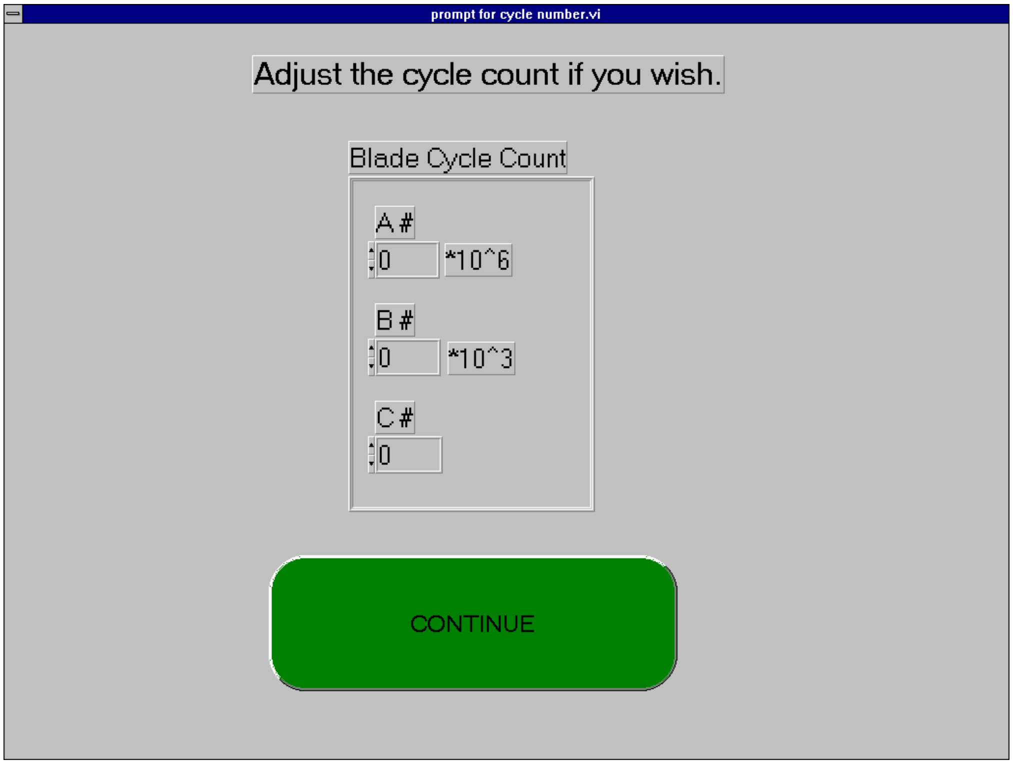


Figure 2.12. Cycle count adjustment window.

This window lets you adjust the cycle count for whatever reason. As with all number controls, you can either triple click on the number and retype it, or you can push the up/down incrementer buttons with the mouse pointer. Pressing **Continue** takes you to either the test time adjustment window, if this is a continued test, or the fatigue test run window, if this is a new test.

2.3.5 Test Time Adjustment Window

You will only see this window if you are **continuing** a previous test.

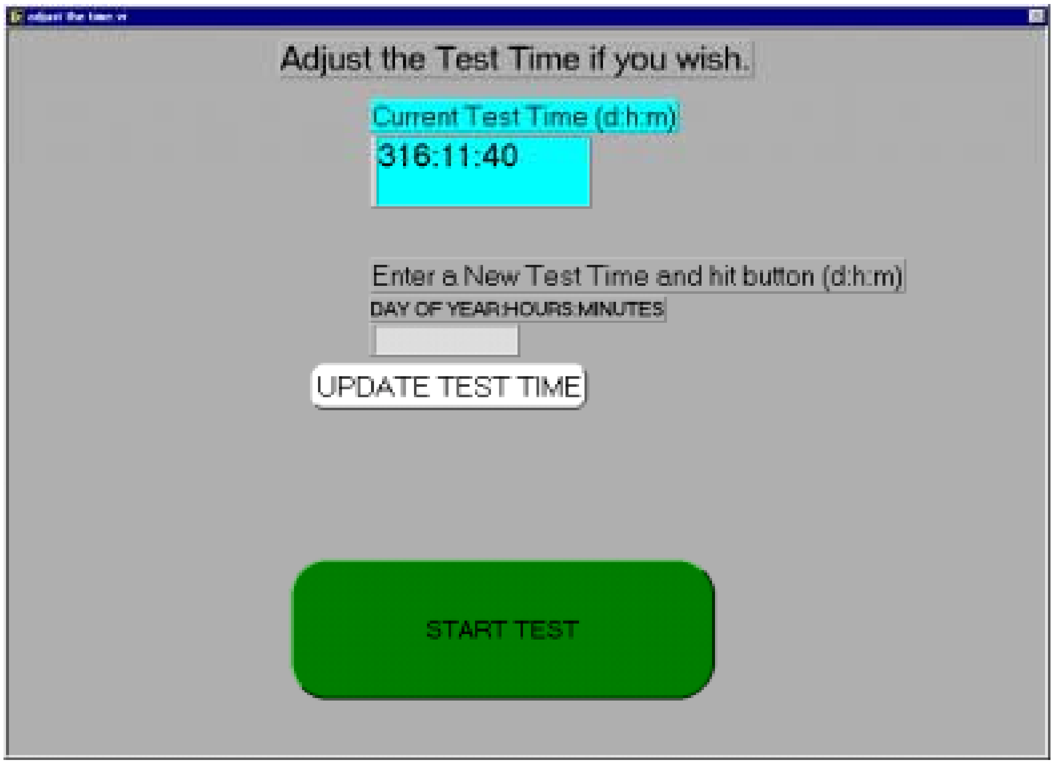


Figure 2.13. Test time adjustment window.

Current Test Time displays what time BSTRAIN thinks it is based on the sample number, the scan rate, and the time the test was started. If you wish to adjust this time, enter a new time in the white box and push the UPDATE TEST TIME button. BSTRAIN will adjust the sample number to create the new test time. If you enter a later time, BSTRAIN will add to the sample number. If you enter an earlier time, BSTRAIN will subtract from the sample number. This means you could possibly create multiple data points with the same sample number (and thus time). Inaccuracies in time arise when the test is stopped for a few days or more, because when BSTRAIN is not collecting data it must rely on the computer's clock to measure how much time has elapsed.

Push continue to go on to the main test window and start acquiring data.

2.3.6 Main Fatigue Test Window

This is the window you see while acquiring data (Fig. 2.14). The header file for a new test (Fig. 2.16) is written as soon as you get to this window, and then updated during operation if needed. Remember, **everything that is white leads you to a control** which accepts user input and should be checked whenever you start up a test. The following text is a explanation of the controls, first, and then the indicators in this window.

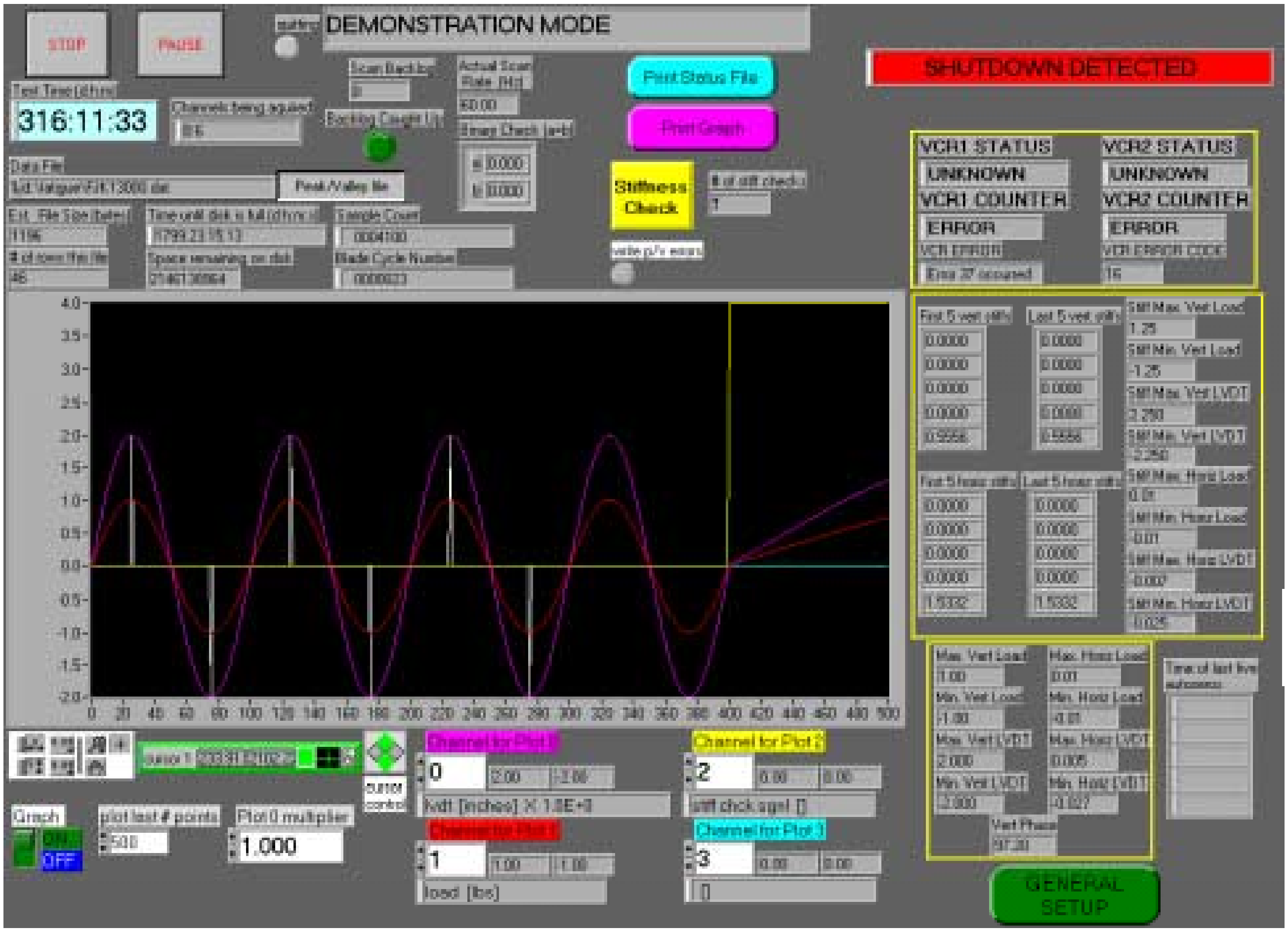


Figure 2.14. Main fatigue test window during normal cyclic operation.

A. Buffer Limit/Scan Backlog

This is a limit for the number of scans in the backlog buffer (scans which have been sampled by the A/D, but have not yet been processed by BSTRAIN). If the Scan Backlog goes over this limit, BSTRAIN shuts down some extraneous features (such as the chart), and attempts to catch up. If you are sampling at 60 Hz and the Scan Backlog is 300 scans, it means that the data you are looking at is 5 seconds old. If the Scan Backlog buffer goes over 50,000 scans, the program will quit.

B. First 5 Stiffness'

The top number in this column is the first stiffness measured during this test and the bottom number is the fifth stiffness.

C. Last 5 Stiffness'

The most recent stiffness measured by BSTRAIN is put at the bottom of this column. These are indicators and the user cannot change the values.

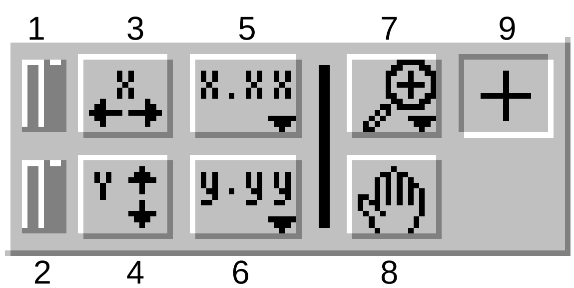
D. Stiffness check loads and displacments

These are the loads and displacements recorded during the most recent stiffness check.

E. Graph

Turns the chart on and off.

F. Graph Control Icons



Button 3) Pressing this button autoscales the x-axis.

Button 4) Pressing this button autoscales the y-axis.

Buttons 1&2) When you press either of these buttons it locks button 3 or 4 in the on (autoscale) position.

Buttons 5&6) Miscellaneous graph formatting options.

Button 7) Zooming tool. Press this button to see different options for zooming.

Button 8) Grabbing tool. Just try it.

Button 9) Cursor tool. Gives you a mouse pointer which will move the cursor.

G. Plot 0 Multiplier

Allows you to scale Plot 0 so that even if it has a small magnitude it can be compared to plots with large magnitudes.

H. Plot Last # Points

Specifies how many scans to display on the chart and thus the time span of the chart. The chart is updated every 100 scans (i.e. one second if the scan rate is 100Hz).

I. Cursor 1/Cursor Control

The cursor appears as a green line with a vertical slash. The two numbers next to "cursor 1" are the x and y coordinates respectively. To move the cursor you can either enter numbers as x and y coordinates or use the mouse to press the buttons on the cursor control.

J. Channel for Plot 0,1,2,3

Specify channels to plot. Use the colors to discern which plot is which channel. The white plot shows where BSTRAIN found the master channels peaks and valleys. It is 0 at all points except at a peak, which is equal to the absolute value of the peak, and a valley, which is equal to the negative of the absolute value of the valley. Thus a peak is always greater than zero and a valley is always less than zero. The digital indicators show the most recent peak and valley found for this channel.

K. Print Status File

Press this button to generate a printout of the test status (Fig. 2.15). Expect it to take a few minutes to print as BSTRAIN uses a great deal of the computer's resources.

L. Print Graph

Press this button to generate a printout of the chart only. Once again expect it to take a few minutes.

M. Time

This is the time that BSTRAIN thinks it is, displayed as day of year:hour:minute. This time can differ from the computer's time since it is calculated based on the sample #, the scan rate, and the initial time at which the test was started. If the time is wrong, you can stop and then continue the test. When you continue a test you are given the option to adjust the test time.

N. Channels Being Acquired

Tells you which channels are currently being sampled.

O. Data File

Path and name of current data file.

P. Est. File Size (bytes)

This is the size of the current data file (*###.dat).

Q. # of Rows This File

This is the number of rows in the current data file.

R. Time Until Disk is Full (d:h:m:s)

Estimated time (days:hours:minutes:seconds) until the data drive is full. If you don't have enough time you will have to use decimation to reduce the rate at which data is written to the drive.

S. Space Remaining on Disk

Number of bytes available on the data disk.

T. Sample Count

This is the number of A/D scans that have been made since the start of the test. If the test is stopped and later continued, the number of missed scans is calculated and added to the sample count.

U. Blade Cycle Number

A count of blade cycles derived from the peak/valley detection.

V. Actual Scan Rate (Hz)

Value returned by the A/D board specifying the scan rate in Hertz.

W. Backlog Caught Up

Normally green. Sticks out and turns red if the program is attempting to process all scans in the backlog.

X. # of Stiff Checks

The number of stiffness checks performed since the start of the test.

Y. VCR Status / VCR Counter / VCR Error

Displays the status and counter of each VCR. If the status is anything other than RECORDING, STOPPED, or REWINDING, it will be displayed as unknown.

Z. Binary / Voltage

This a binary value and voltage from the first channel. Make sure that the binary value agrees with the voltage value: 16 bits of resolution provides a binary range of 2^16 (65536) for the voltage range of 5.0 to -5.0 Volts, thus 5.0 Volts is about 32768 bits and 1.0 Volt is about 6554 bits.

AA. Peak/Valley Detection Error/Channel

This indicator appears if there is a peak valley detection error and shows the responsible channel.

BB. Shutdown Detected

This indicator appears if a shutdown is detected.

CC. Error With Network Drive N:

This indicator appears if the Network switch is off or if the switch is on and BSTRAIN could not write to drive N: .

DD. Pause

When this button is depressed the program pauses data collection.

EE. Stop

Stops acquisition, stops the VCR’s, closes the current data file, makes a phone call if desired and exits the fatigue test. Any backlogged data will be lost.

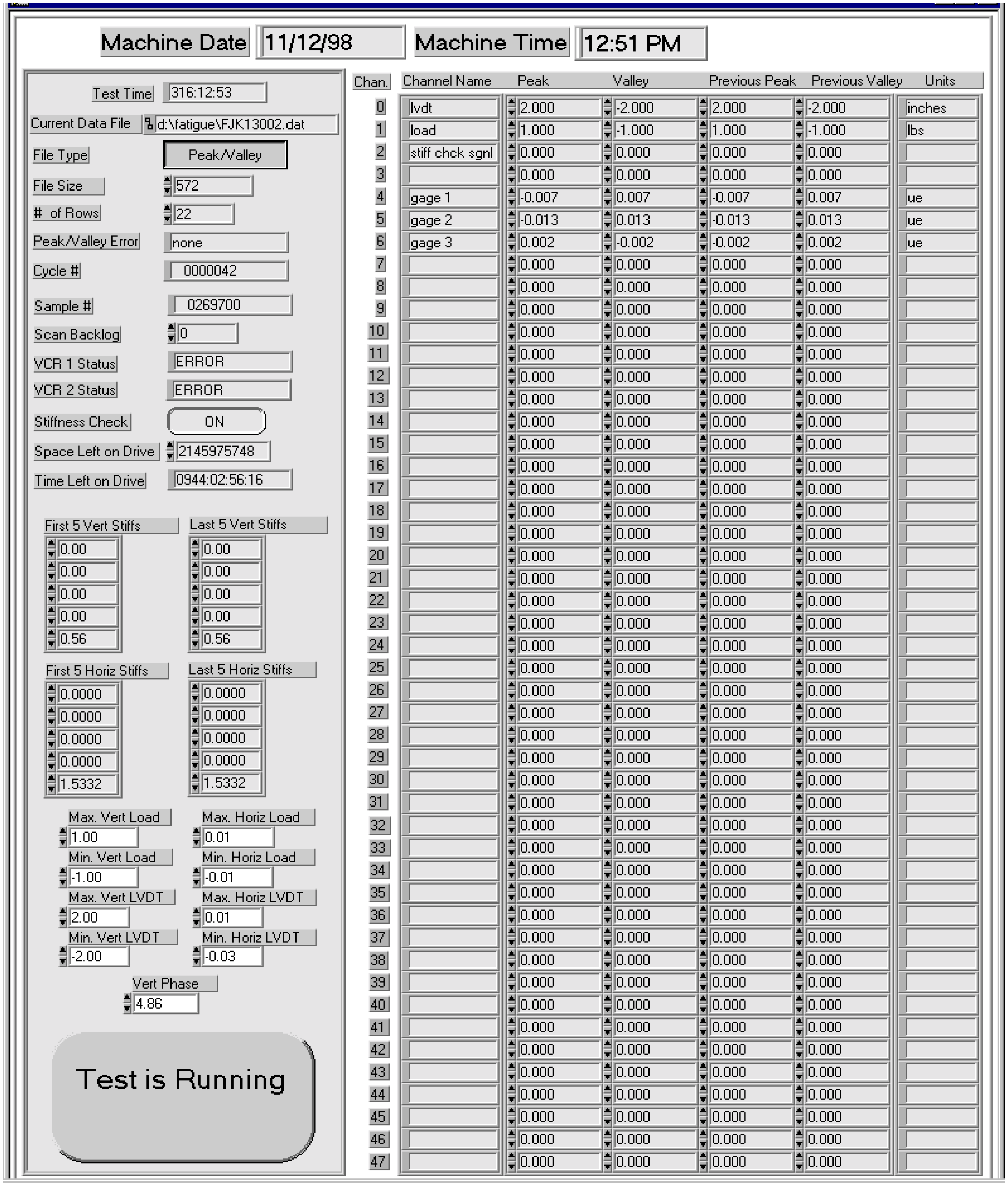


Figure 2.15. Status printout.

Test Name: FJK13
Experiment Type: fatigue test
Blade:
Date: 11/12/1998
Time: 11:39 AM
Julian Date: 316:11:39
Comments: This is a fatigue test of
Computer: Gateway E-3100
Software: LabVIEW 5.01 for Windows 95
A/D Board: PCI-MIO-16XE-10
Signal Conditioning: SCXI
Scan Frequency (Hz): 6.0000E+1
Number of Channels: 7
Max file size (bytes): 1400000
Max rows per file: 15000
Flap Displacement Channel: 0
Flap Load Cell Channel: 1
Stiff Check Signal Channel: 2
Max Blade Freq. (Hz): 1.0000E+0
Max Blade Freq. During Stiff Check (Hz): 1.0000E-1
P/V Window (samples): 5
P/V Window During Stiff Check (samples): 50
Dual-Axis Test: YES
Edge Displacement Channel: 4
Edge Load Channel: 5
Flap actuator length at zero displacement (Lf): 9.6000E+1
Edge actuator length at zero displacement (Le): 6.0000E+1
Distance between flap and edge actuators (Lx): 9.6000E+1
Length of the pushrod (LPR): 1.3200E+2
Length of the bell-crank (LBCx): 3.6000E+1
Height of the bell-crank (LBCy): 3.6000E+1
Distance from floor to bell-crank pivot (LBCPy): 6.0000E+1
Bell-crank pivot to edge actuator (LBCPex): 3.6000E+1
Vertical Zero Load: 0.000000E+0
Horiz. Zero Load: 0.000000E+0
Channels to Autozero: 4:6

Chnnl#	Error Detect	Name	Units	DAQ Gain	A(x-D)^3	B(x-D)^2	C(x-D)	D(Volts)
0	ON	lvdt	inches	1.0000E+0	0.0000E+0	0.0000E+0	3.0000E+0	4.8828E-3
1	ON	load	lbs	1.0000E+0	0.0000E+0	0.0000E+0	3.0000E+3	7.0190E-3
2	OFF	stiff chck sgnl		1.0000E+0	0.0000E+0	0.0000E+0	1.0000E+0	0.0000E+0
3	OFF			0.0000E+0	0.0000E+0	0.0000E+0	1.0000E+0	0.0000E+0
4	ON	36R39UA	ue	5.0000E+2	0.0000E+0	0.0000E+0	5.8829E+5	-4.4556E-2
5	ON	36R39UB	ue	5.0000E+2	0.0000E+0	0.0000E+0	5.7977E+5	-6.0577E-2
6	ON	36R39UC	ue	5.0000E+2	0.0000E+0	0.0000E+0	5.8829E+5	1.5106E-2

WARNING: Master signal peak # 52883835 is less than valley # 52883987 on channel 0
WARNING: Master signal peak # 52883835 and valley # 52883987 differ by less than 0.5% of full scale on channel 0

Figure 2.16. Example header file.

2.3.6.1 General Setup Sub-Window

When you press the general setup button in the fatigue test you are presented the following window (Fig. 2.17). The is where you set a number of options for the fatigue test in real-time.

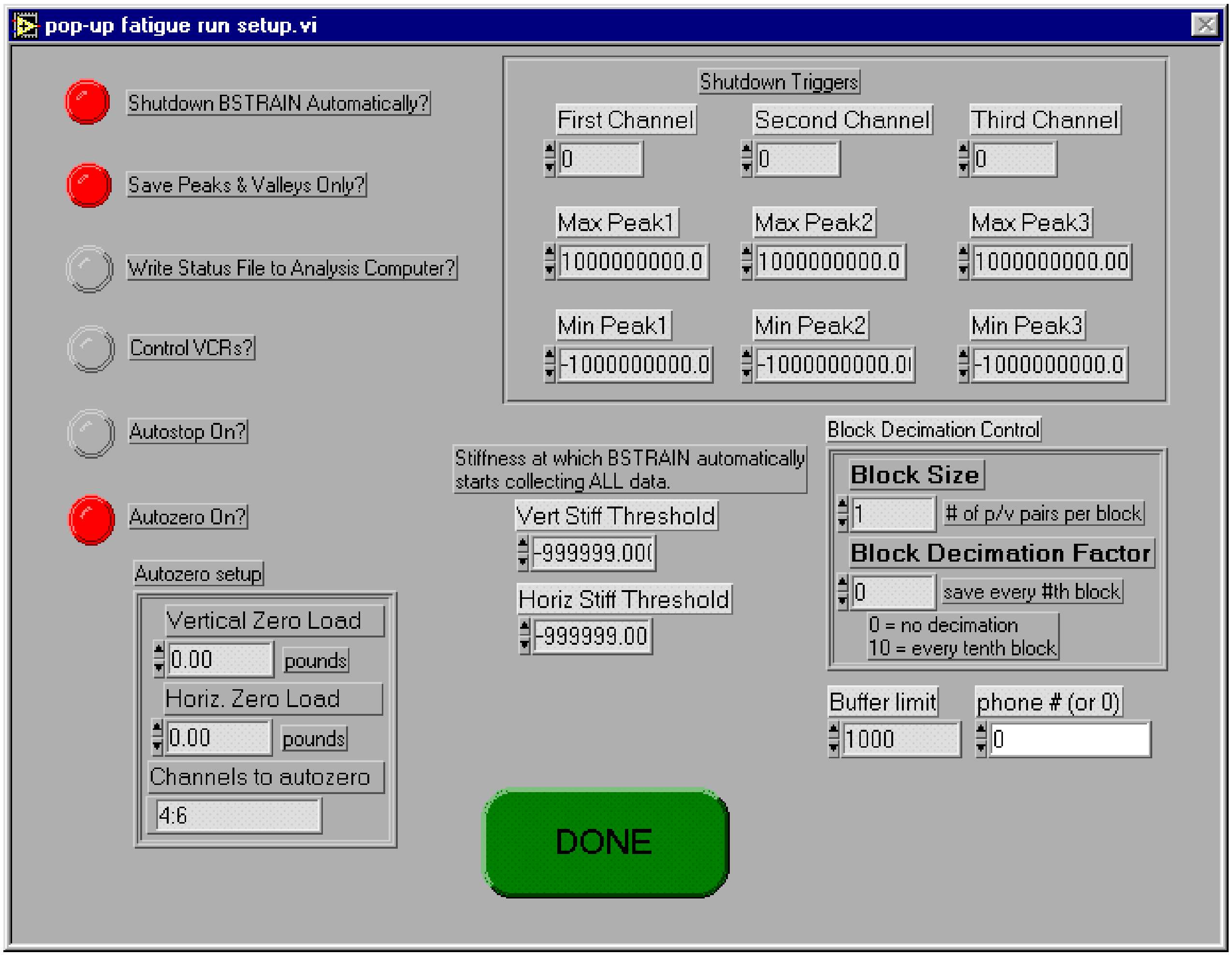


Figure 2.17. General setup sub-window in the fatigue test.

A. Shutdown BSTRAIN Automatically?

If this is turned on (red), BSTRAIN will stop data acquisition when a shutdown is detected continuously for 5 minutes. A shutdown is detected when every channel has less than a three percent span between it's maximum and minimum values over a quarter cycle.

B. Save Peaks & Valleys Only?

If selected, BSTRAIN only saves peaks and valleys. Otherwise, all data is saved.

C. Write Status File to Analysis Computer?

If selected, BSTRAIN writes the status file to the analysis computer every few seconds. This is required for remote BSTATUS. If this is selected and the network is not functioning it could cause a data backlog.

D. Control VCRs?

If selected, BSTRAIN attempts to loop two Panasonic VCRs.

E. Autostop On? and Shutdown Triggers

If selected, BSTRAIN monitors the Shutdown Triggers and sends a shutdown signal when the limits are exceeded. The shutdown signal is a serial command (TRAC responds to this) and a +5 Volt signal on analog output channel 0 (0 Volts during normal operation).

F. Autozero On? and Autozero Setup

Specify whether or not to attempt autozeroing every stiffness check.

G. Stiffness Thresholds

If either stiffness goes below it's threshold value, the program switches to time series data storage.

H. Block Decimation Control

Allows you to decimate data or decimate blocks of data. This option only works with peak/valley data storage. A block decimation factor of 0 means save every block (no decimation, this is the default), while a factor of 10 would mean only save every 10th block. Block size allows you to group peak/valley pairs into blocks and decimate those blocks. For example, if block size is set to 5 and block decimation is set to 10, data would be saved as follows: save five pairs of peaks and valleys (10 values), discard 45 pairs (5 * 9), save five pairs, discard 45 pairs, ...

2.4 Binary to ASCII Conversion Program

2.4.1 Installation

All that is needed to run the conversion program is the file LVconvert.exe. This is a standalone version of the BSTRAIN conversion program which can be run on any computer. It can be copied to any directory.

2.4.2 Converting Data

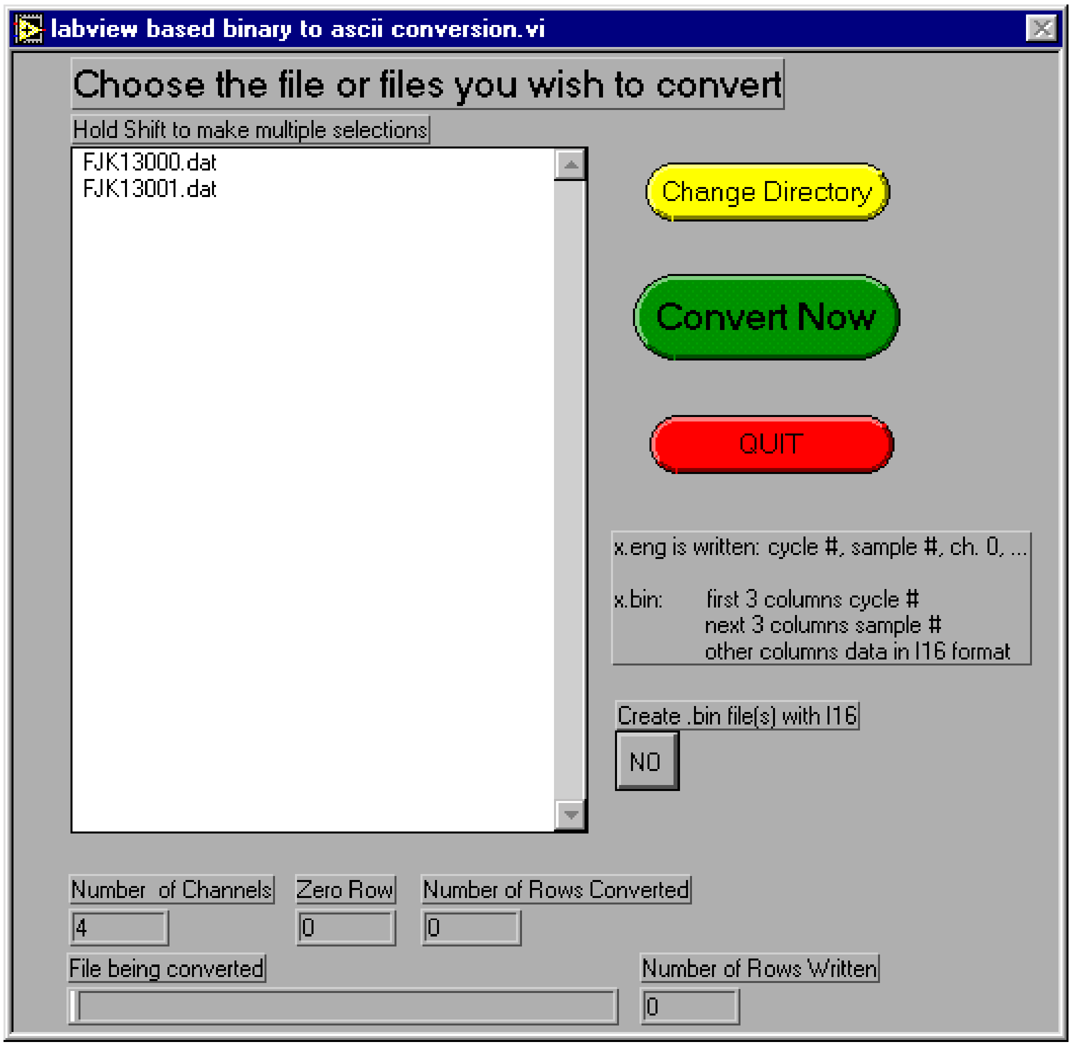


Figure 2.18. Conversion window.

This program is designed to input a binary data file created in BSTRAIN with data acquired from a static or fatigue structural test and convert the raw data into a readable ASCII format using the appropriate engineering units. It can be executed from either BSTRAIN or as a standalone program.

An accompanying header file must be present in the same path as the data file and must be created by BSTRAIN. The header file name should be the first five characters of the data file name and should have an extension of .hdr. Example: fjk13.hdr for the data file fjk13001.dat.

After entering the filename, the program converts the data and saves the header information and tab delimited data in a file with the same path and filename as the .dat file, but with the extension .eng. This file is easily viewed in an Excel spreadsheet. Figure 2.19 is an example of an engineering file.

LVconvert also creates a file with ASCII representation of the binary values (*.bin).

Files that were created from static and fatigue test earlier than the fall of 1995 can still be converted using the same program as long as they have the correct filename specifications: must start with “f” or “s” and be five or eight characters long. Any header file that has been modified and is missing lines, tabs, etc. will still convert, assuming that the mandatory information is still present (i.e. number of channels, sample frequency and Julian test start time).

File name: Fjk13										
Experiment type: fatigue test, inboard section										
Blade: TEST, S/N 210357										
Date: 10/21/95										
Test start time: 09:58 AM										
Julian time: 294: 9:58										
Comment: Finished previous load block at 500K cycles; changed loading from 3000ue to 3200 ue; now										
running at 13797/2916 lbs. Load-block count = 0 cycles.										
Computer: HP Vectra VL 5/100										
Software: LabVIEW 3.1.1 for Windows										
A/D Board: AT-MIO-16X										
Signal Conditioning: SCXI										
Scan Frequency (Hz): 60.										
Number of channels: 19										
P/V Window (samples): 43										
Maximum file size (bytes): 140										
Maximum rows per file: 15000										
Displacement channel: 0										
Stiff check signal channel: 2										
Load cell channel: 1										
Maximum blade frequency (Hz): 0.400										
Maximum blade frequency during stiffness check: 0.100										
P/V window (samples): 43										
P/V window during stiffness check (samples): 17										
Zero load: 0.1707000E+04										
Channels to autozero: 4: 1										
Autozero file found										
TIME	CYCLE #	lvdt	load	stiff chck s		36R39UA	36R39UB	36R39UC	36R39LA	25R42UA
		inches	lbs			ue	ue	ue	ue	ue
313: 7:52:34.0	588372	14.56	13721.01	0.858	0	-3372.87	-1292.13	776.296	2740.733	-3191.45
313: 7:52:35.2	588372	-11.577	2763.977	0.852	0	-1434.64	-73.78	107.72	202.153	-240.663
313: 7:52:36.5	588373	14.554	13718.26	0.851	0	-3452.58	-1294.61	777.373	2738.579	-3190.73
313: 7:52:37.7	588373	-11.571	2769.47	0.857	0	-1490.65	-70.949	106.283	208.616	-241.022
313: 7:52:39.0	588374	14.553	13721.92	0.858	0	-3176.46	-1290.72	778.81	2741.451	-3191.09
313: 7:52:40.2	588374	-11.575	2770.386	0.852	0	-1407.35	-72.011	108.438	206.462	-240.663
313: 7:52:41.5	588375	14.558	13725.59	0.852	0	-3439.65	-1290.01	776.655	2738.938	-3192.53
313: 7:52:42.7	588375	-11.579	2770.386	0.858	0	-1533.02	-68.826	108.438	204.666	-240.304
313: 7:52:44.0	588376	14.56	13724.67	0.857	0	-3454.73	-1291.78	774.142	2743.606	-3194.32
313: 7:52:45.2	588376	-11.575	2763.977	0.852	0	-1513.63	-72.718	105.206	210.77	-241.022
313: 7:52:46.5	588377	14.555	13718.26	0.858	0	-3416.31	-1294.61	777.014	2737.502	-3190.73
313: 7:52:47.7	588377	-11.582	2764.893	0.851	0	-1515.07	-73.78	108.438	207.898	-240.304
313: 7:52:49.0	588378	14.565	13726.5	0.852	0	-3413.44	-1293.9	777.014	2740.015	-3195.04
313: 7:52:50.2	588378	-11.578	2766.724	0.857	0	-1507.89	-71.657	105.924	203.589	-242.817
313: 7:52:51.5	588379	14.556	13712.77	0.852	0	-3193.69	-1290.72	777.014	2744.324	-3194.68
313: 7:52:52.7	588379	-11.573	2763.062	0.858	0	-1377.19	-73.072	107.36	206.102	-243.176
313: 7:52:54.0	588380	14.566	13714.6	0.852	0	-3403.39	-1289.66	777.014	2742.888	-3192.89
313: 7:52:55.2	588380	-11.577	2766.724	0.857	0	-1441.82	-72.365	108.797	203.589	-240.304
313: 7:52:56.5	588381	14.566	13729.25	0.858	0	-3369.63	-1293.19	775.937	2741.811	-3191.45
313: 7:52:57.7	588381	-11.581	2765.808	0.851	0	-1505.73	-72.365	105.924	207.18	-239.945
313: 7:52:59.0	588382	14.556	13720.09	0.852	0	-3367.84	-1290.72	777.014	2740.374	-3194.68
313: 7:53: 0.2	588382	-11.58	2762.146	0.857	0	-1487.06	-72.718	108.438	208.616	-243.895
313: 7:53: 1.5	588383	14.561	13719.18	0.852	0	-3449.35	-1293.55	774.86	2739.297	-3189.65
313: 7:53: 2.7	588383	-11.577	2767.639	0.858	0	-1480.6	-74.842	108.797	206.462	-244.613
313: 7:53: 4.0	588384	14.567	13728.33	0.857	0	-3403.74	-1290.01	775.578	2743.247	-3194.32
313: 7:53: 5.2	588384	-11.578	2765.808	0.851	0	-1519.74	-70.949	108.797	206.102	-242.099

Figure 2.19. Example engineering file (.eng).*

2.5 Data Processing

The data processing section allows you to generate a header file summary or a zero file summary.

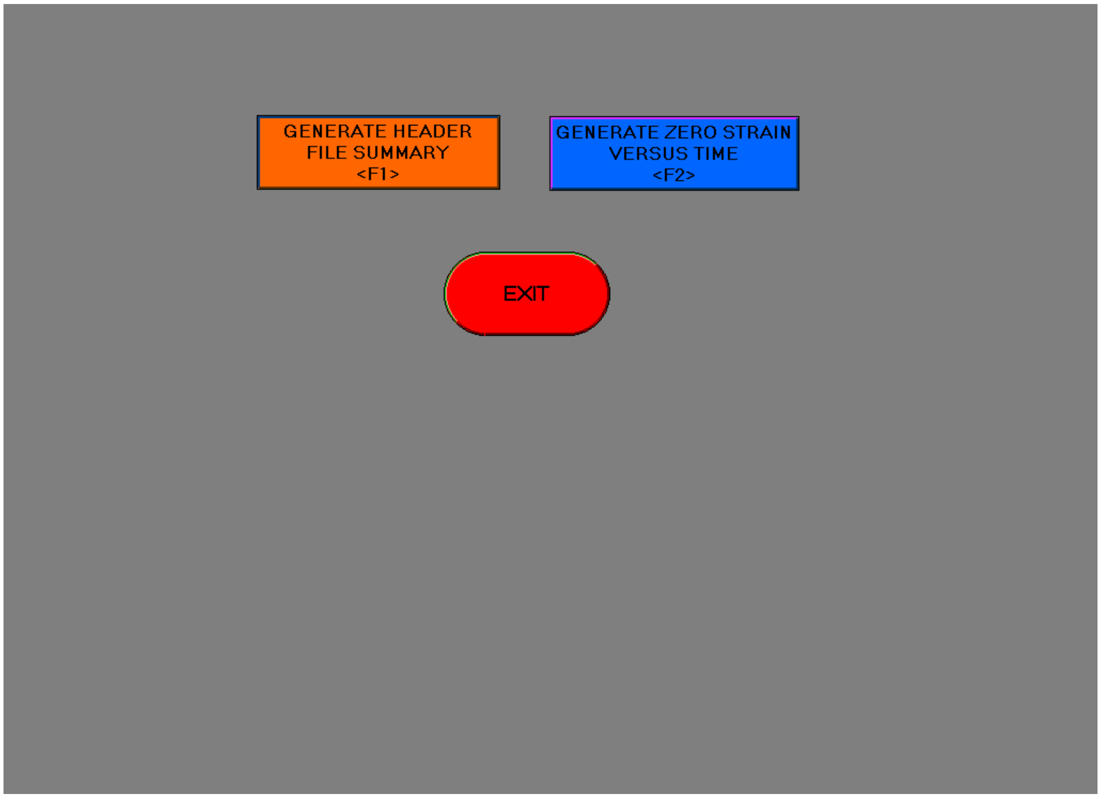


Figure 2.20. Data processing initial window.

2.5.1 Generate Header File Summary

One of the options of the data processing menu (Fig. 2.20) is to create a header file summary. Press this button and you will be prompted to select a directory. The program will then summarize all header files in the chosen directory and generate a file called bheader.sum such as that shown in Fig. 2.21.

D:\FATIGUE
DATE: 11/28/95
TIME: 02:27 PM

Test Name: Fjk13   Blade: junk, S/N 210357   Date: 10/21/95   Julian Date: 294:9:58
Comments: Finished previous load block at 500K cycles; changed loading from 3000ue to 3200 ue; now running at 13797/2916 lbs. Load-block count = 0 cycles.

Test Name: Fjk14   Blade: junk, S/N 210357   Date: 11/14/95   Julian Date: 319:12:57
Comments: Finsihed previous 3200 ue load block at 597,453 cycles. Installed 40", 20 kip actuator, applying new load of 16918/3228 lbs. at 4000ue on Ch. 8 gage. Load-block count = 0

Test Name: Fjk15   Blade: junk, S/N 210357   Date: 11/17/95   Julian Date: 321:10:23
Comments: Calibrated LVDT, changed cal factors, added a spacer at top of actuator. Test continues at 4000 ue level. Load-block count = 42,016 cycles.

Test Name: Fjk16   Blade: junk, S/N 210357   Date: 11/21/95   Julian Date: 325:14:30
Comments: Test continues at 4000 ue level. Load-block count = 133,038 cycles.

Figure 2.21. Example of a "bheader.sum" file.

2.5.2 Generate Zero Strain Versus Time

The second option in Figure 2.20 is to create a zero strain versus time file. This option reads the autozero data file (*.zro) and converts the measurements to engineering units. The allows you to look at how the zeroes were changing over time.

2.6 Shunt Calibration and/or Hardware Nulling

The shunt cal/ hardware nulling program allows you to acquire data without writing it to disk. It is useful for hardware nulling (zeroing the strain gage channels by adjusting the nulling potentiometer on the SCXI 1321) and allows you to connect the internal shunt calibration resistor of the SCXI 1321. When commanded by this program, the SCXI 1321 places its shunt cal resistor across the EX+ and CH+ terminals (Fig. G.1).

2.6.1 Setup Window

Hitting the "Shunt Calibration and/or Hardware Nulling" button brings up the window shown in Fig. 2.22.

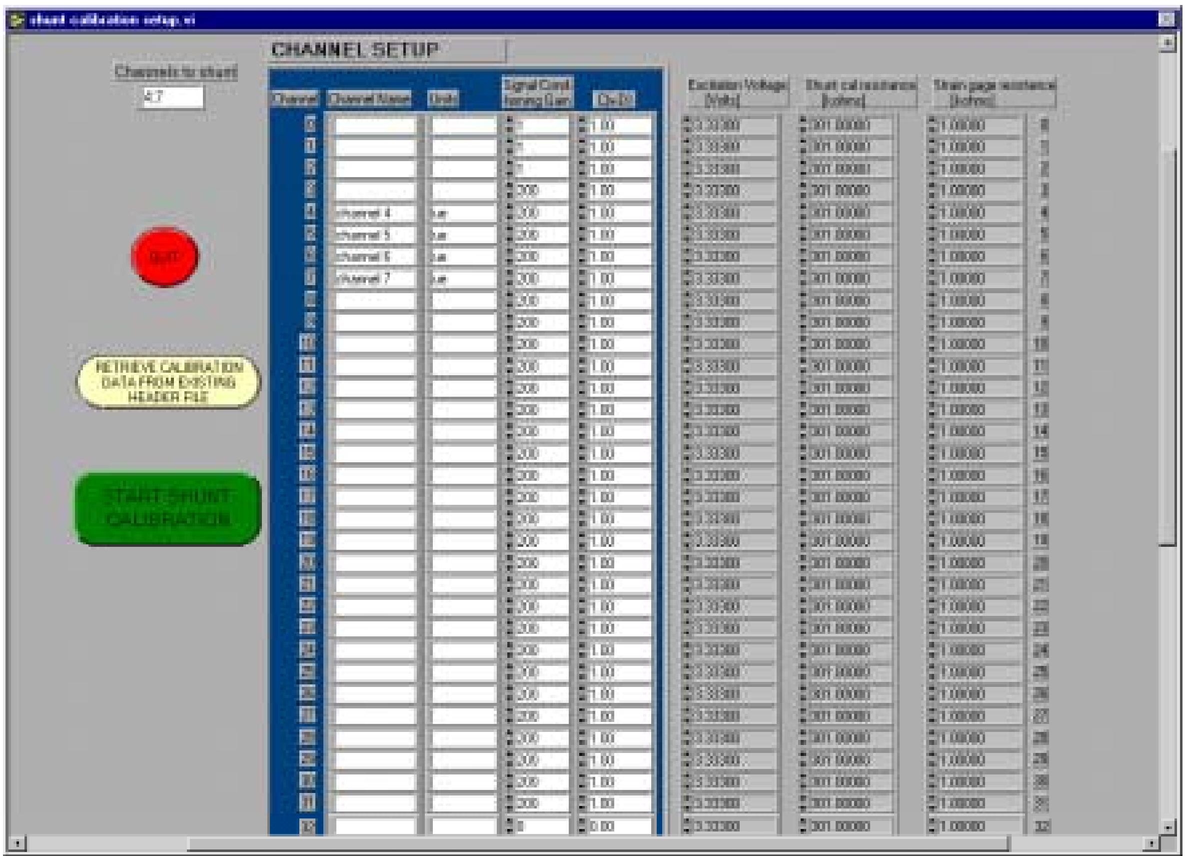


Figure 2.22. Shunt calibration/hardware nulling setup window.

A. Channels to Shunt

Enter the channel(s) that you wish to sample and shunt. You can enter a single channel (e.g., 2) or a range of channels (e.g., 2:13).

B. Retrieve Calibration Data From Existing Header File

If you have already entered channel setup data for this test into a header file, you can retrieve it using this command.

C. Channel Name, Units

Enter a name and units for each channel you are going to use, by clicking on the desired box with the mouse and typing the desired information.

D. Signal Conditioning Gain

This is where you tell BSTRAIN what gain you are using in the SCXI equipment. Channels 0,1, and 2 are always going to be 1 (lvdt, load cell and stiffness check signal, for a fatigue test). 200 is a typical value for other channels (see Chapter 1). You can enter values by selecting the desired cell with the mouse and typing (try triple-clicking on the number to make sure you delete all characters in the box, even something that might be hidden), or you can increment the value in the box by hitting its up down buttons with the mouse.

E. C(x-D)

This is the constant by which you multiply the strain gage voltage (from Fig. 1.6, Table 2).

F. Excitation Voltage [Volts], Shunt Cal Resistance [kohms], Strain Gage Resistance [kohms]

Enter these values so that BSTRAIN can predict the expected shunt cal strain. The factory installed shunt cal resistance is 301 kohms. Note that resistances are in **kilo**ohms.

G. Quit

Hit this button to return to the main window.

H. Start Shunt Calibration

Hit this button after you are finished with this screen, to go to the run window which is described next.

2.6.2 Run Window

After completing the shunt calibration setup window, the run window is opened. While in the run window (Fig. 2.23), the program samples the selected channels at about 2Hz and displays the results. The procedure for shunt calibration would be to:

1) hardware null the selected channels with shunt calibration OFF using the "error as a percentage of full scale" to estimate your error,

2) activate the shunt calibration (places a resistor across the EX+ and CH+ inputs, Fig. G.1, of the SCXI 1321) and compare the measured values with expected values.

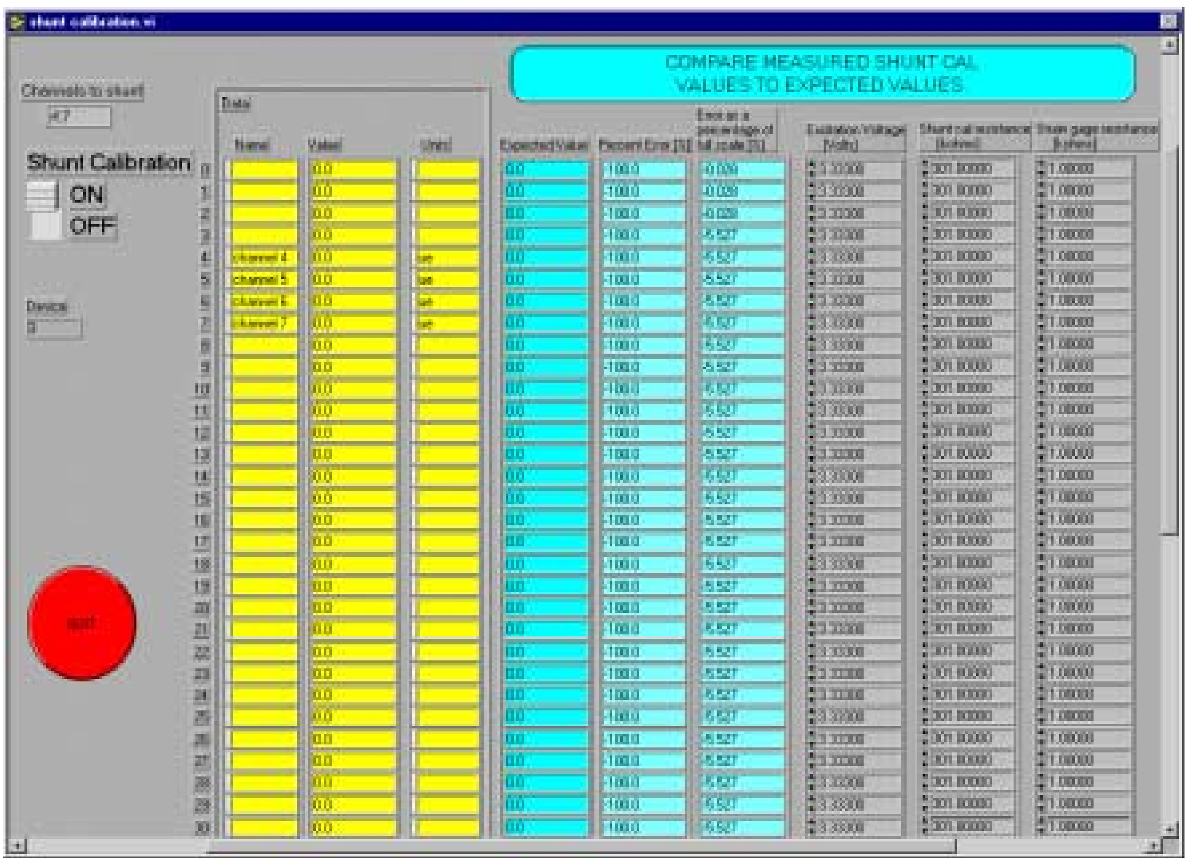


Figure 2.23. Shunt calibration/hardware nulling main window.

A. Shunt Calibration

Toggling this switch activates/deactivates the shunt calibration resistor.

B. Value

The measured value. With shunt cal OFF it should be zero, with shunt cal ON you can compare it to the expected value.

C. Expected Value

This is the expected value of the strain gage.

D. Percent Error [%]

The error between the measured and expected value as a percentage of the expected value.

E. Error as a Percentage of Full Scale [%]

The error between the measured and expected value as a percentage of full scale.

2.7 Demonstration Mode

Demonstration mode allows you to simulate a fatigue or static test in BSTRAIN. You can use the demo file editor to create virtually any type of simulated data, and then run that data through BSTRAIN.

2.7.1 Initial Window

Hitting the "Demonstration Mode" button on the main menu brings up the window shown in Fig. 2.24. From this window you can start a simulated fatigue or static test or edit/create a demo data file.

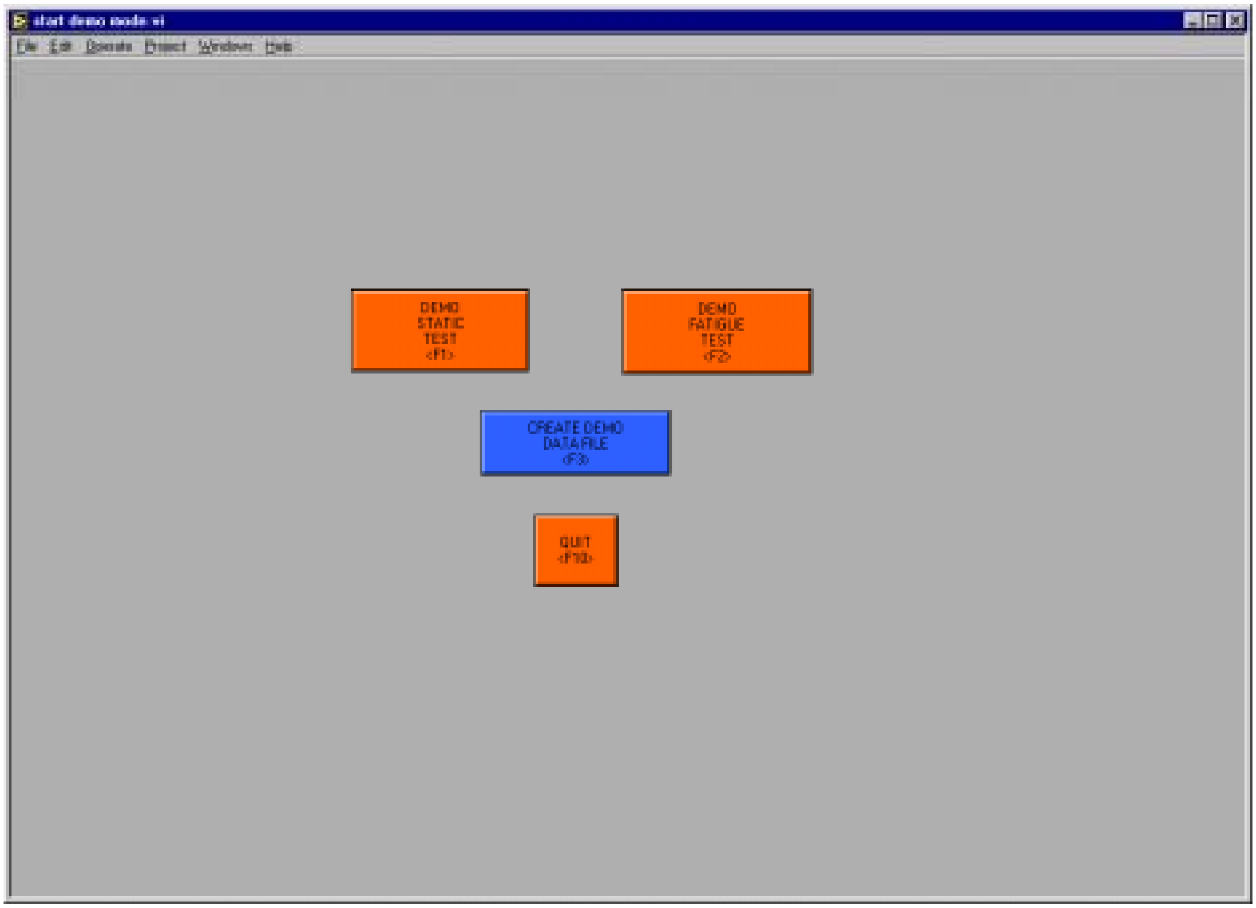


Figure 2.24. Shunt calibration/hardware nulling setup window.

2.7.2 Create Demo Data File

This program allows you to create or edit a demonstration data file. You build whatever waveforms you would like to run through BSTRAIN, and save them in a file called demo.dem. When you run a demonstration fatigue or static test, it reads the data from c:\bstrain\demo.dem and repeats it until you stop the test.

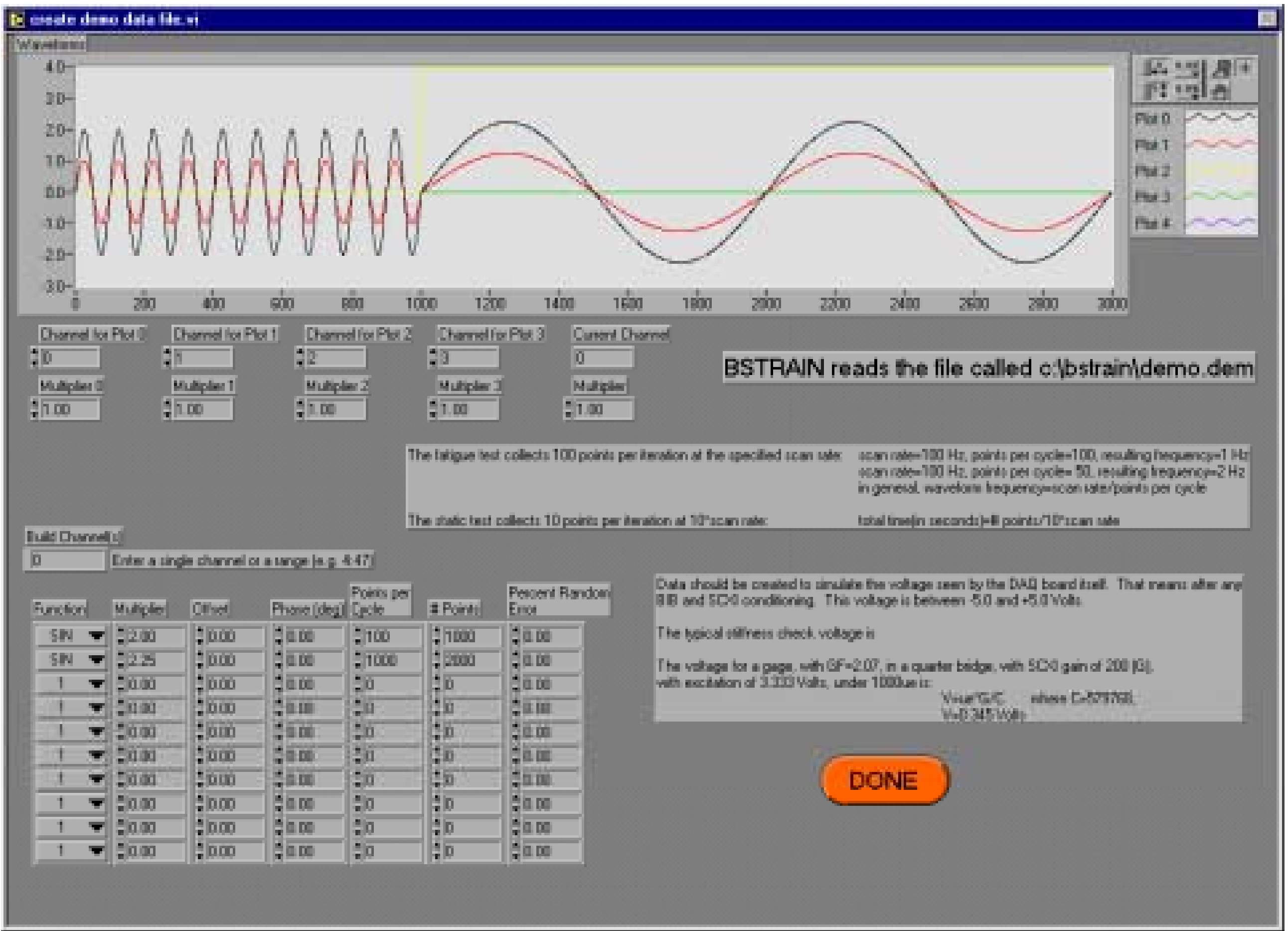
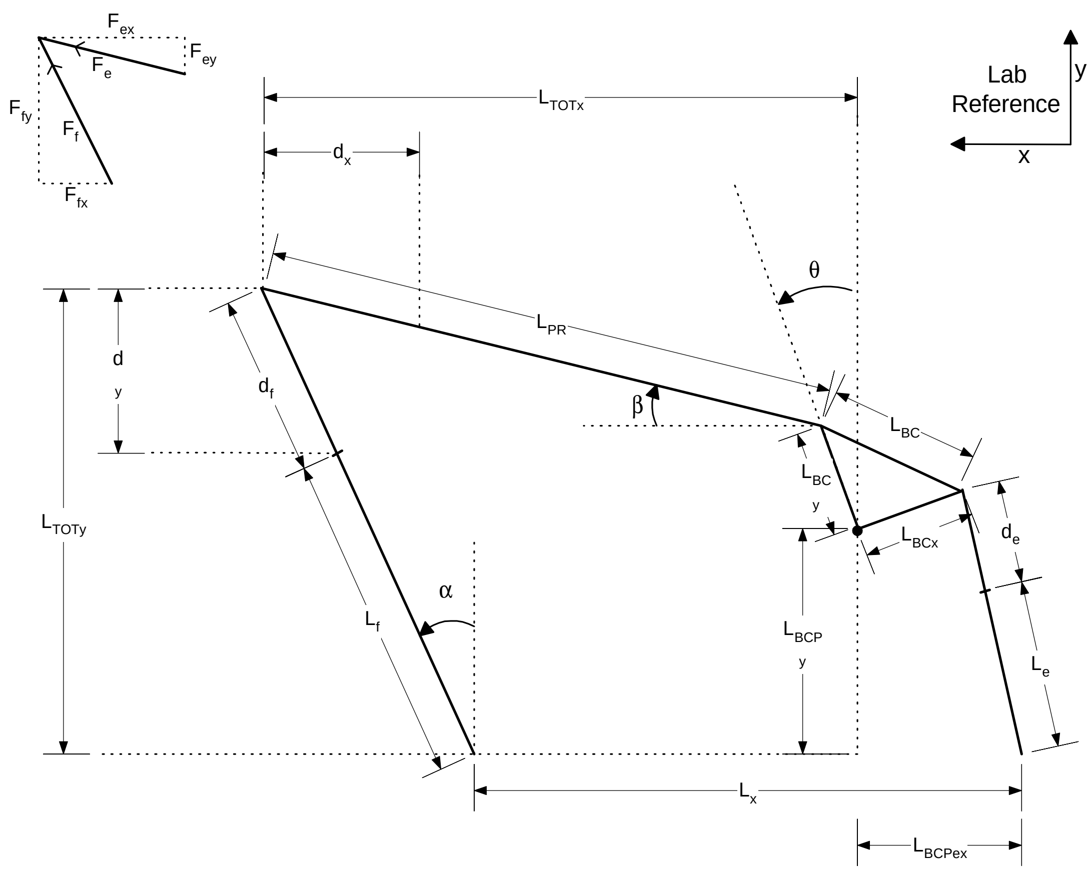


Figure 2.25. Create demo data window.

2.8 2-Axis Utilities

This section involves the geometric corrections applied to the measured loads and displacements in a 2-Axis test. Figure 2.26 is a line drawing which defines the variables and constants used in the geometric corrections.



L_x	Distance from flap actuator to edge actuator (const.)
L_e	Edge actuator length at zero displacement (const.)
L_f	Flap actuator length at zero displacement (const.)
L_{PR}	Pushrod. Distance from bell-crank to blade junction (const.)
L_{BCy}	Height of bell-crank (const.)
L_{BCx}	Length of bell-crank (const.)
L_{BCPy}	Distance from floor to bell-crank pivot (const.)
L_{BCPex}	Horizontal distance from bell-crank pivot to edge actuator (const.)
d_e	Displacement of edge actuator (meas.)
d_f	Displacement of flap actuator (meas.)
β	Pushrod angle (calc.)
α	Flap actuator angle (calc.)
L_{TOTx}	Distance from bell-crank pivot to blade junction (calc.)
L_{TOTy}	Distance from floor to blade junction (calc.)
d_x	Actual horizontal displacement (calc.)
d_y	Actual vertical displacement (calc.)
F_f	Flap load (meas.)
F_e	Edge load (meas.)
F_x	Actual horizontal load (calc.) = $F_{ex} + F_{fx}$
F_y	Actual vertical load (calc.) = $F_{ey} + F_{fy}$

Figure 2.26. 2-Axis lab reference drawing.

Following are the equations which are used to calculate the actual horizontal and vertical displacements and loads, from the measured flap and edge displacements and loads. Refer to Figure 2.26 for variable and constant definitions:

$$\theta = \cos^{-1}\left[\frac{L_{BCPy}^2 + L_{BCPex}^2 + L_{BCx}^2 - (L_e + d_e)^2}{2L_{BCx}\sqrt{L_{BCPy}^2 + L_{BCPex}^2}}\right] + \tan^{-1}\left[\frac{L_{BCPex}}{L_{BCPy}}\right] - \frac{\pi}{2}$$

$$\alpha = \cos^{-1}\left[\frac{(L_x - L_{BCPex} - L_{BCy}\sin\theta)^2 + (L_{BCPy} + L_{BCy}\cos\theta)^2 + (L_f + d_f)^2 - L_{PR}^2}{2(L_f + d_f)\sqrt{(L_x - L_{BCPex} - L_{BCy}\sin\theta)^2 + (L_{BCPy} + L_{BCy}\cos\theta)^2}}\right]$$
$$- \tan^{-1}\left[\frac{L_x - L_{BCPex} - L_{BCy}\sin\theta}{L_{BCPy} + L_{BCy}\cos\theta}\right]$$

$$\beta = \cos^{-1}\left[\frac{(L_x - L_{BCPex} - L_{BCy}\sin\theta)^2 + (L_{BCPy} + L_{BCy}\cos\theta)^2 - (L_f + d_f)^2 + L_{PR}^2}{2L_{PR}\sqrt{(L_x - L_{BCPex} - L_{BCy}\sin\theta)^2 + (L_{BCPy} + L_{BCy}\cos\theta)^2}}\right]$$
$$- \tan^{-1}\left[\frac{L_{BCPy} + L_{BCy}\cos\theta}{L_x - L_{BCPex} - L_{BCy}\sin\theta}\right]$$

$$L_{TOTx} = L_{PR}\cos\beta + L_{BCy}\sin\theta$$
$$L_{TOTy} = (L_f + d_f)\cos\alpha$$

$$d_x = L_{TOTx}(d_f, d_e) - L_{TOTx}(0,0)$$

$$d_y = L_{TOTy}(d_f, d_e) - L_{TOTy}(0,0)$$

$$F_x = F_e\cos\beta + F_f\sin\alpha$$
$$F_y = F_e\sin\beta + F_f\cos\alpha$$

2.8.1 Initial 2-Axis Utilities Window

Figure 2.27 is the initial window that appears when you select 2-axis utilities from the main BSTRAIN menu. You can either run the 2-axis control determination (2ACD) program or use the calculator to calculate vertical and horizontal values for given flap and edge loads and displacements.

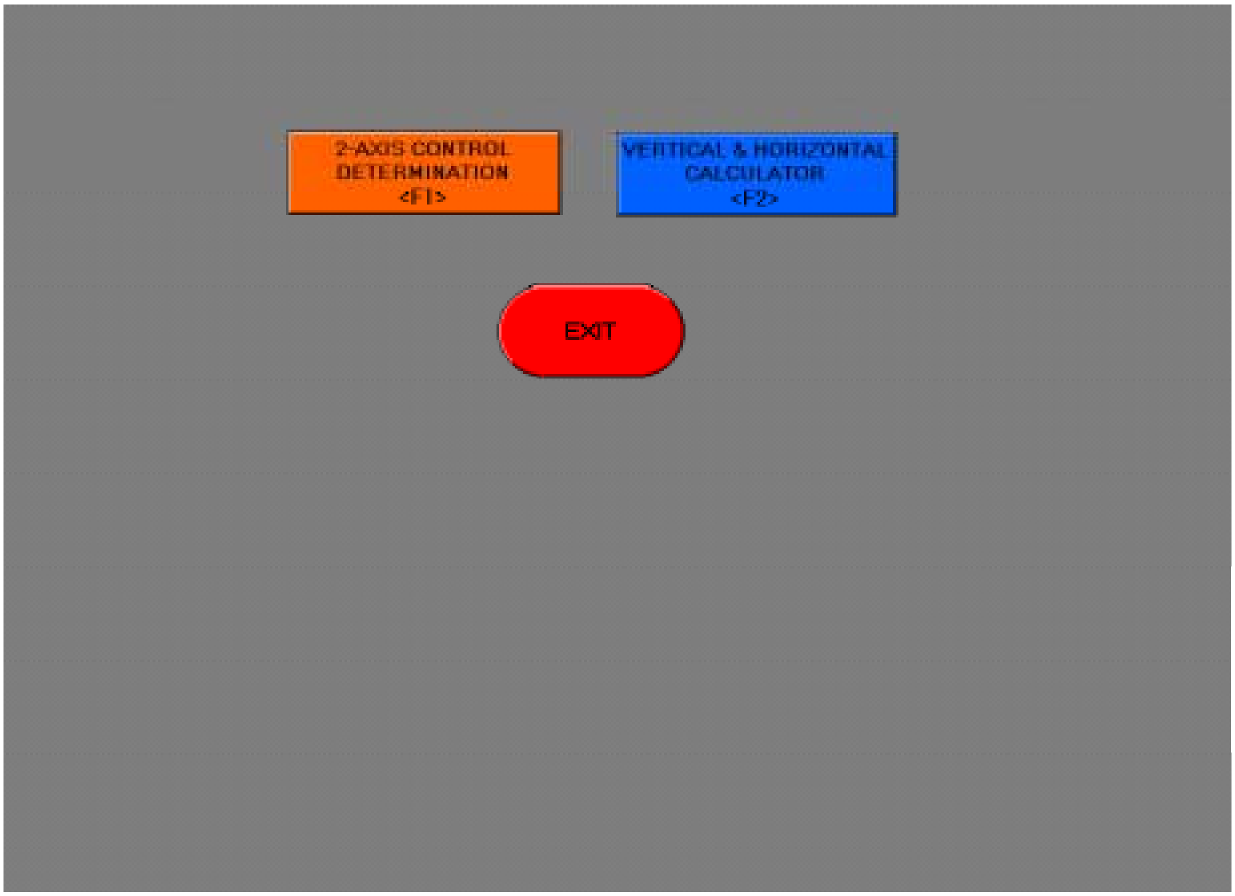


Figure 2.27. Initial 2-axis utilities window.

2.8.2 Analog Setup for 2ACD

If you choose to run 2ACD in Figure 2.27, you are first presented with the analog input setup window (Fig. 2.28).

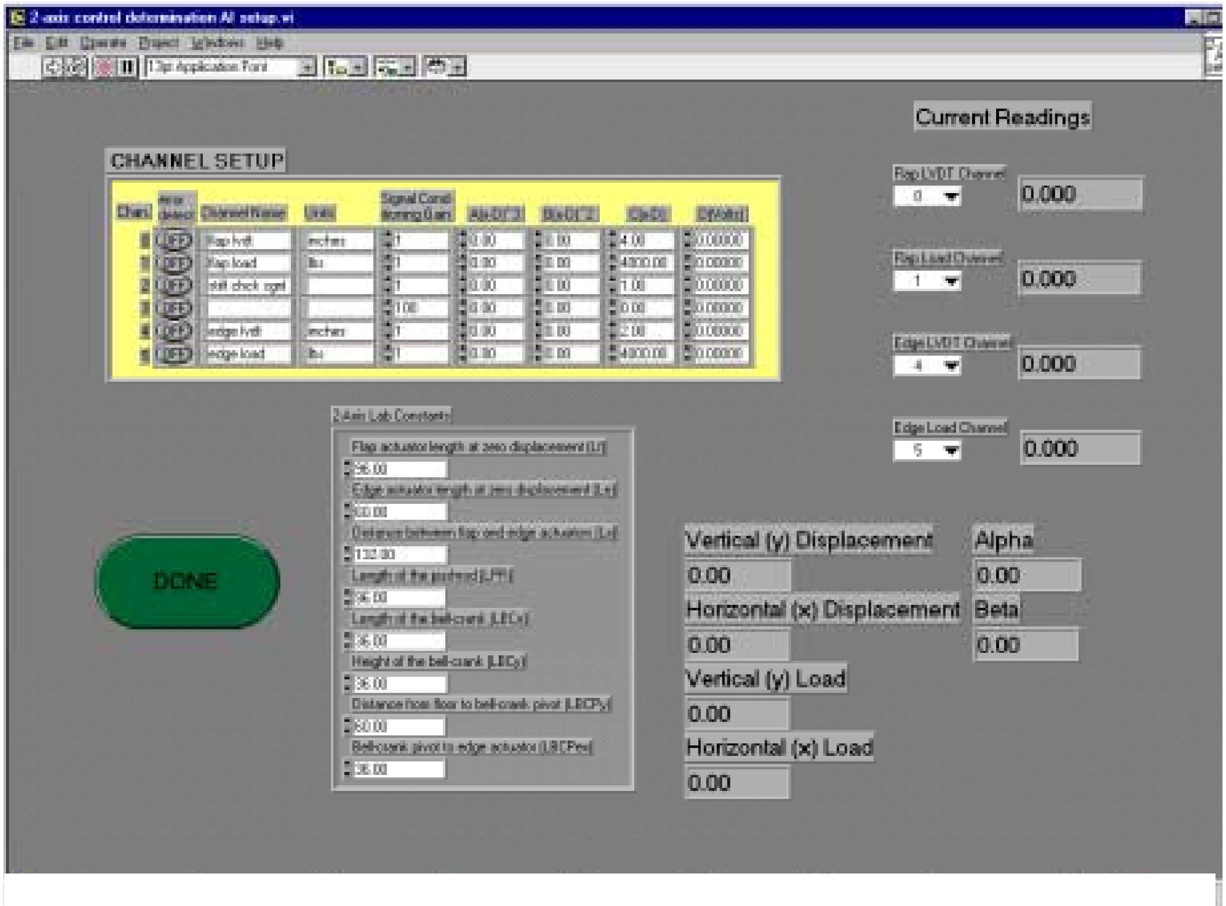


Figure 2.28. 2-axis control determination analog input setup window.

Fill in "Channel Setup" as you would normally to read data into BSTRAIN. These values should be the same as those you use during actual testing, so if D will be zero during testing use zero here also. You must define 5 channels; flap & edge displacement, flap & edge load, and stiffness check signal. These signals all come from FlexTest analog outputs.

On the right side of the window you must tell 2ACD which channel goes with which measurement.

2-Axis lab constants must be measured with a tape measure and entered here.

2.8.3 2-Axis Control Determination (2ACD)

2ACD is used to determine the flap and edge control signals needed to achieve the desired vertical and horizontal loads. The main screen is shown in Figure 2.29.

2ACD uses analog outputs to send control signals to FlexTest. Currently in use is a 12-bit ISA card from National Instruments (PC-AO-2DC). The relevant connections are:

10	D/A out 0,
12	D/A out 1,
11	Analog Ground.

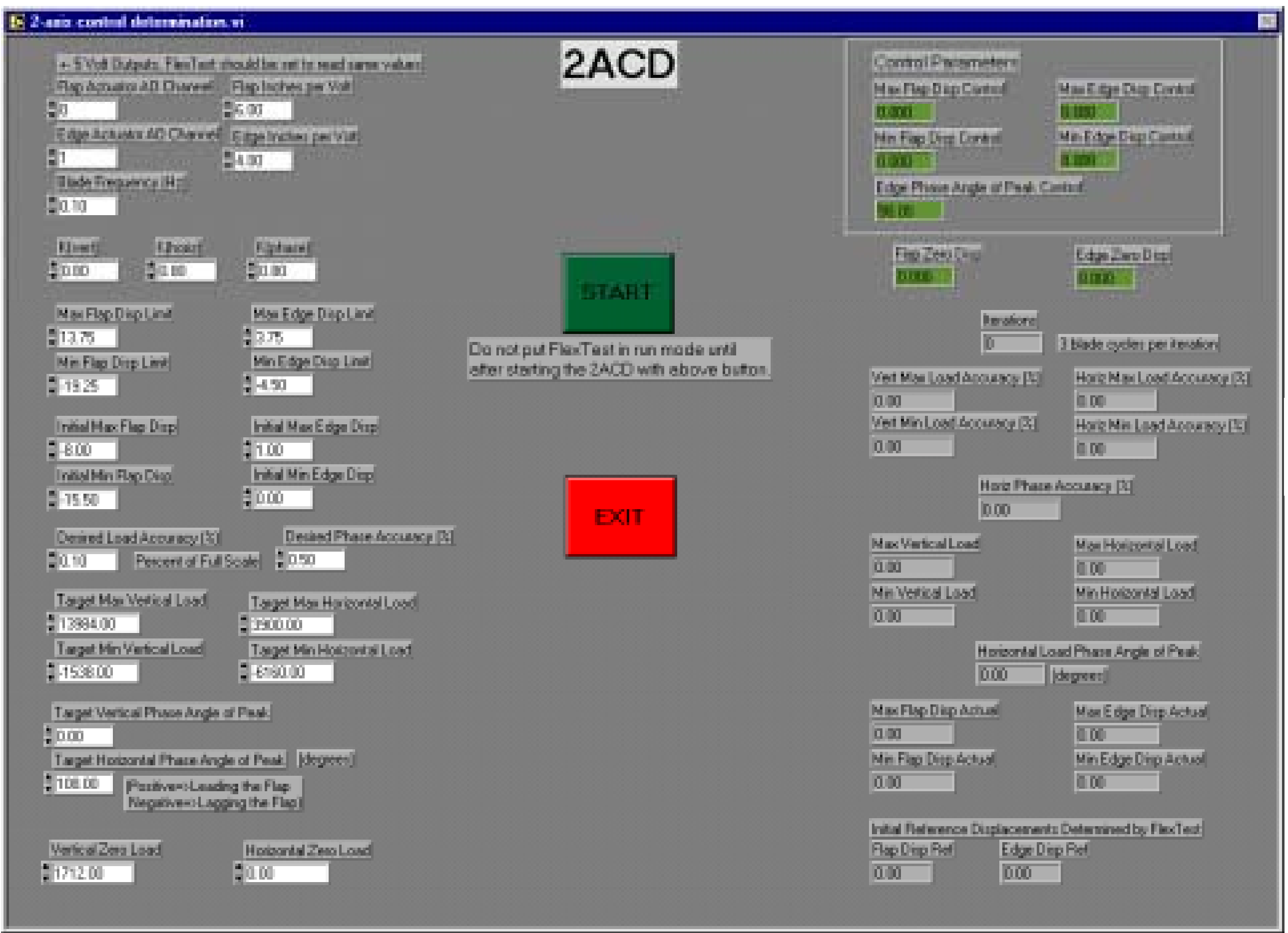


Figure 2.29. 2-axis control determination main window.

Operation of 2ACD is as follows:

1) Enter the proper values in all the input controls.

   a) Output channel setup:

      Inches/Volt = 2*Actuator Span / 2ACD Analog Output Span (10 volts).

      The gain and full scale maximum and minimum must also be set correctly in FlexTest (adjust inputs => calibration => full scale maximum, full scale minimum, and gain):

      FlexTest gain = FlexTest analog input span (20 V) / 2ACD analog output span (10 V),

      full scale max = 2 * actuator max,

      full scale min = 2 * actuator min.

   b) Blade frequency is generally set to the same frequency used during stiffness checks.

   c) K is the proportionality constant by which the error is multiplied before correcting the control signal. Values greater than 1 are not recommended.

   d) Maximum and minimum displacement limits are set just below FlexTest's limits to keep 2ACD from triggering a shutdown.

   e) Initial displacements tells 2ACD where to start iterating from.

   f) Desired accuracy determines how close the measured loads must be to the target loads to stop iterating.

   g) Enter the target loads, phase angle, and zero loads.

2) Press the start button.

3) Start FlexTest and continue 2ACD.

4) 2ACD measures the initial flap and edge displacement, since FlexTest uses these as a reference for the input signals (i.e. if the initial flap displacement is –15 inches, and it is desired to send the actuator to +20 inches, a control signal corresponding to +35 inches must be sent).

5) 2ACD determines the zero displacements by adjusting the flap and edge displacement until the vertical and horizontal loads are within 0.05% full scale of the desired zero loads.

6) 2ACD iterates until the control displacements are found:

   a) Output three cycles of flap and edge displacement control signals.

   b) Find the horizontal and vertical maximum and minimum of the resultant load signal.

   c) Calculate the resultant phase angle.

   d) If the errors are greater than the desired accuracy, adjust the control signal as control=control-(K*error) and repeat.

7) Return the blade to it's initial position.

8) Save the iterative data to file if desired.

9) Create block profiles for FlexTest if desired.

2.8.4 Create Block Profile Files For FlexTest

After 2Acd finishes iterating, it can create the block profile files for FlexTest. Three files are created:

1) fast cycle profile (normal testing),
2) first slow cycle profile (stiffness check),
3) second slow cycle profile (autozero).

The second slow cycle profile must be executed right after the first slow cycle profile, and the stiffness signal should be on during both.

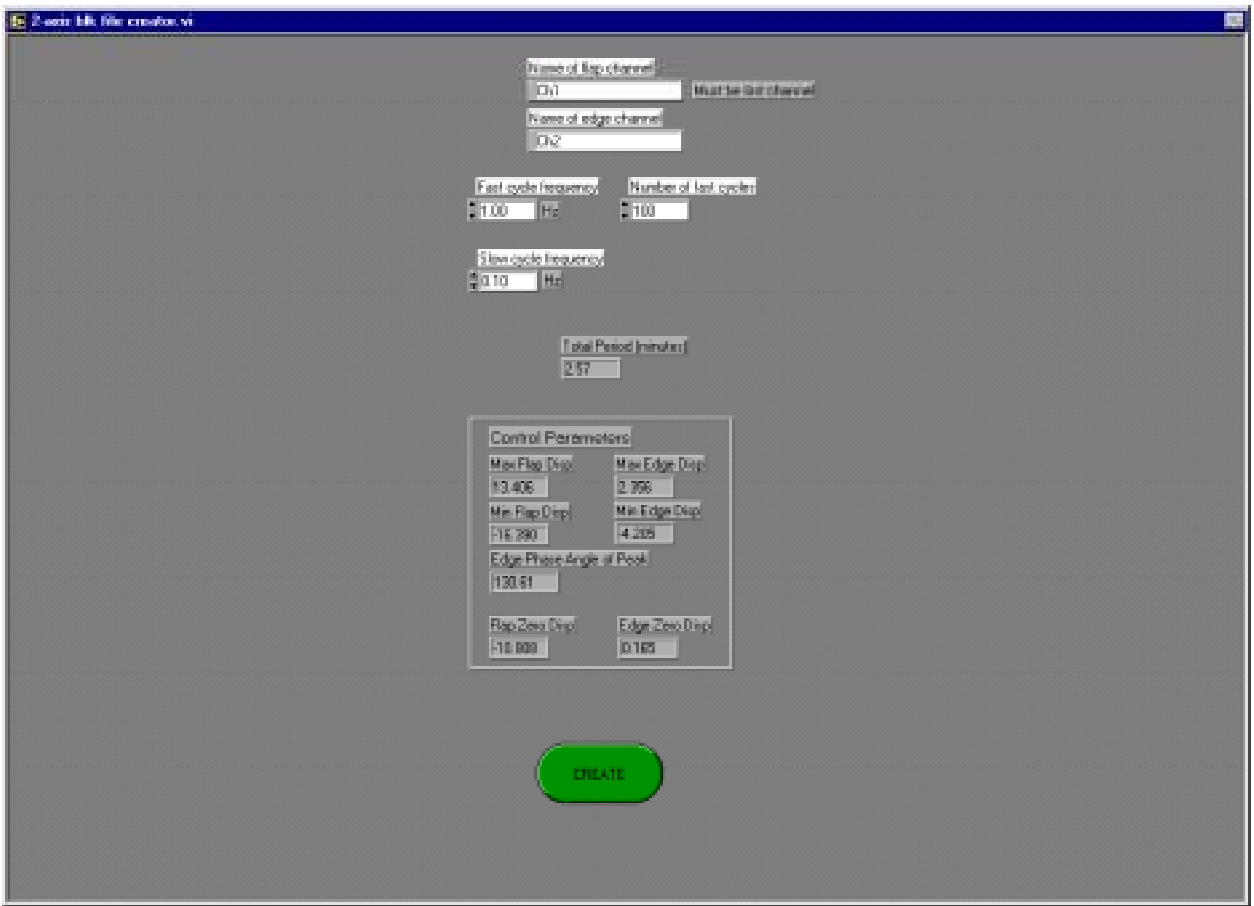


Figure 2.30. 2-axis block file creator window.

APPENDIX A

70 WIRE BIB BOX CONNECTIONS

Index	Color	Color	Color	Color	Hole	SCXI	
1	black				J2	-CH	
2	brown				J1	+CH	
3	red				J3	+sense	
4	orange				J4	-sense	Channel 1
5	yellow				J6	-EX	
6	green				J5	+EX	
7	blue				J14	+aux	
8	violet				J15	-aux	
9	gray				J2	-CH	
10	white				J1	+CH	
11	white	black			J3	+sense	
12	white	brown			J4	-sense	Channel 2
13	white	red			J6	-EX	
14	white	orange			J5	+EX	
15	white	yellow			J14	+aux	
16	white	green			J15	-aux	
17	white	blue			J2	-CH	
18	white	violet			J1	+CH	
19	white	gray			J3	+sense	
20	white	black	brown		J4	-sense	Channel 3
21	white	black	red		J6	-EX	
22	white	black	orange		J5	+EX	
23	white	black	yellow		J14	+aux	
24	white	black	green		J15	-aux	
25	white	black	blue		J2	-CH	
26	white	black	violet		J1	+CH	
27	white	black	gray		J3	+sense	
28	white	brown	red		J4	-sense	Channel 4
29	white	brown	orange		J6	-EX	
30	white	brown	yellow		J5	+EX	
31	white	brown	green		J14	+aux	
32	white	brown	blue		J15	-aux	
33	white	brown	violet		J2	-CH	
34	white	brown	gray		J1	+CH	
35	white	red	orange		J3	+sense	
36	white	red	yellow		J4	-sense	Channel 5
37	white	red	green		J6	-EX	
38	white	red	blue		J5	+EX	
39	white	red	violet		J14	+aux	
40	white	red	gray		J15	-aux	
41	white	orange	yellow		J2	-CH	
42	white	orange	green		J1	+CH	
43	white	orange	blue		J3	+sense	
44	white	orange	violet		J4	-sense	Channel 6
45	white	orange	gray		J6	-EX	
46	white	yellow	green		J5	+EX	
47	white	yellow	blue		J14	+aux	
48	white	yellow	violet		J15	-aux	
49	white	yellow	gray		J2	-CH	
50	white	green	blue		J1	+CH	
51	white	green	violet		J3	+sense	
52	white	green	gray		J4	-sense	Channel 7
53	white	blue	violet		J6	-EX	
54	white	blue	gray		J5	+EX	
55	white	violet	gray		J14	+aux	
56	white	black	brown	red	J15	-aux	
57	white	black	brown	orange	J2	-CH	
58	white	black	brown	yellow	J1	+CH	
59	white	black	brown	green	J3	+sense	
60	white	black	brown	blue	J4	-sense	Channel 8
61	white	black	brown	violet	J6	-EX	
62	white	black	brown	gray	J5	+EX	
63	white	black	red	yellow	J14	+aux	
64	white	black	red	green	J15	-aux	

APPENDIX B

40 WIRE BIB BOX CONNECTIONS

Index	Base color	First Color	Second Color	Hole	SCXI	
1	black			J2	-CH	
2	brown			J1	+CH	
3	red			J6	-EX	
4	orange			J5	+EX	Channel 1
5	yellow			J2	-CH	
6	green			J1	+CH	
7	blue			J6	-EX	
8	violet			J5	+EX	Channel 2
9	gray			J2	-CH	
10	white			J1	+CH	
11	white	black		J6	-EX	
12	white	brown		J5	+EX	Channel 3
13	white	red		J2	-CH	
14	white	orange		J1	+CH	
15	white	yellow		J6	-EX	
16	white	green		J5	+EX	Channel 4
17	white	blue		J2	-CH	
18	white	violet		J1	+CH	
19	white	gray		J6	-EX	
20	white	black	brown	J5	+EX	Channel 5
21	white	black	red	J2	-CH	
22	white	black	orange	J1	+CH	
23	white	black	yellow	J6	-EX	
24	white	black	green	J5	+EX	Channel 6
25	white	black	blue	J2	-CH	
26	white	black	violet	J1	+CH	
27	white	black	gray	J6	-EX	
28	white	brown	red	J5	+EX	Channel 7
29	white	brown	orange	J2	-CH	
30	white	brown	yellow	J1	+CH	
31	white	brown	green	J6	-EX	
32	white	brown	blue	J5	+EX	Channel 8
33	white	brown	violet			
34	white	brown	gray			
35	white	red	orange			
36	white	red	yellow			
37	white	red	green			Spares
38	white	red	blue			
39	white	red	violet			
40	white	red	gray			

APPENDIX C

LabVIEW KEYSTROKES

Not necessary for BSTRAIN operation

NEW	**CTRL + N**
OPEN	**CTRL + O**
CLOSE	**CTRL + W**
PRINT WINDOW	**CTRL + P**
EXIT	**CTRL + Q**
CUT	**CTRL + X**
COPY	**CTRL + C**
PASTE	**CTRL + V**
RUN	**CTRL + R**
STOP	**CTRL + .**

<u>APPENDIX D</u>

Files Created by BSTRAIN

*Files in **bold** are meant for the user (ASCII format). View with a word processor or spreadsheet.*

Static Test

s????.hdr	**header file**
s????.dat	binary data file
s????.eng	**engineering units data file (results from the conversion of a *.dat file)**
bheader.sum	**summary of header files**

Fatigue Test

f????.hdr	**header file**
f????.log	**events log file (open with a text editor to see what events have occurred)**
f????.old	continuation file (used by bstrain to continue a test)
f????.stf	**stiffness file (open with excel to see all the stiffness' calculated for this test)**
f????.sts	status file (written over the network to the analysis computer and then used by BSTATUS)
f????.zro	zero file (zeroes measured using the autozero function, automatically incorporated in the conversion process)
f????###.dat	binary data file
f????###.eng	**engineering units data file (results from the conversion of a *.dat file)**
bheader.sum	**summary of header files**

APPENDIX E

Fatigue Test Events

This is a listing of events which generate a listing in the log file

1 Test stopped, Scan Backlog exceeded 50000

2 P/V file started

3 Time series file started

4 Test stopped at user request

5 Stiffness went below threshold

6 There was a LabVIEW DAQ or file error

7 BSTRAIN attempted to make a phone call

8 The disk capacity went below 1000 bytes

9 Test stopped due to shutdown detected

10 Stop command sent to MTS 498 due to trigger threshold

Appendix F

LCD Counter Box

This is a simple device for counting the cycles of a voltage waveform at up to 40 Hz. To use it you simply connect the displacement or load signal to V_{signal}. No power is required, and the count can only be lost by pressing the reset button. The potentiometer allows you to adjust the minimum peak-to-peak voltage required to trigger a count, from about .6 Volts to about 5 Volts.

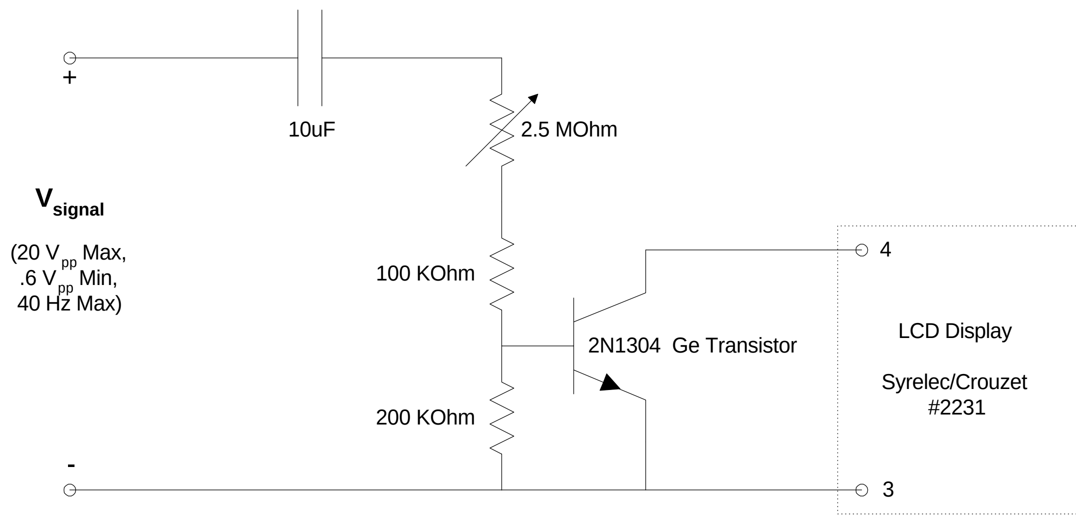


Figure F.1. LCD counter circuit diagram.

Appendix G

Hardware Diagrams

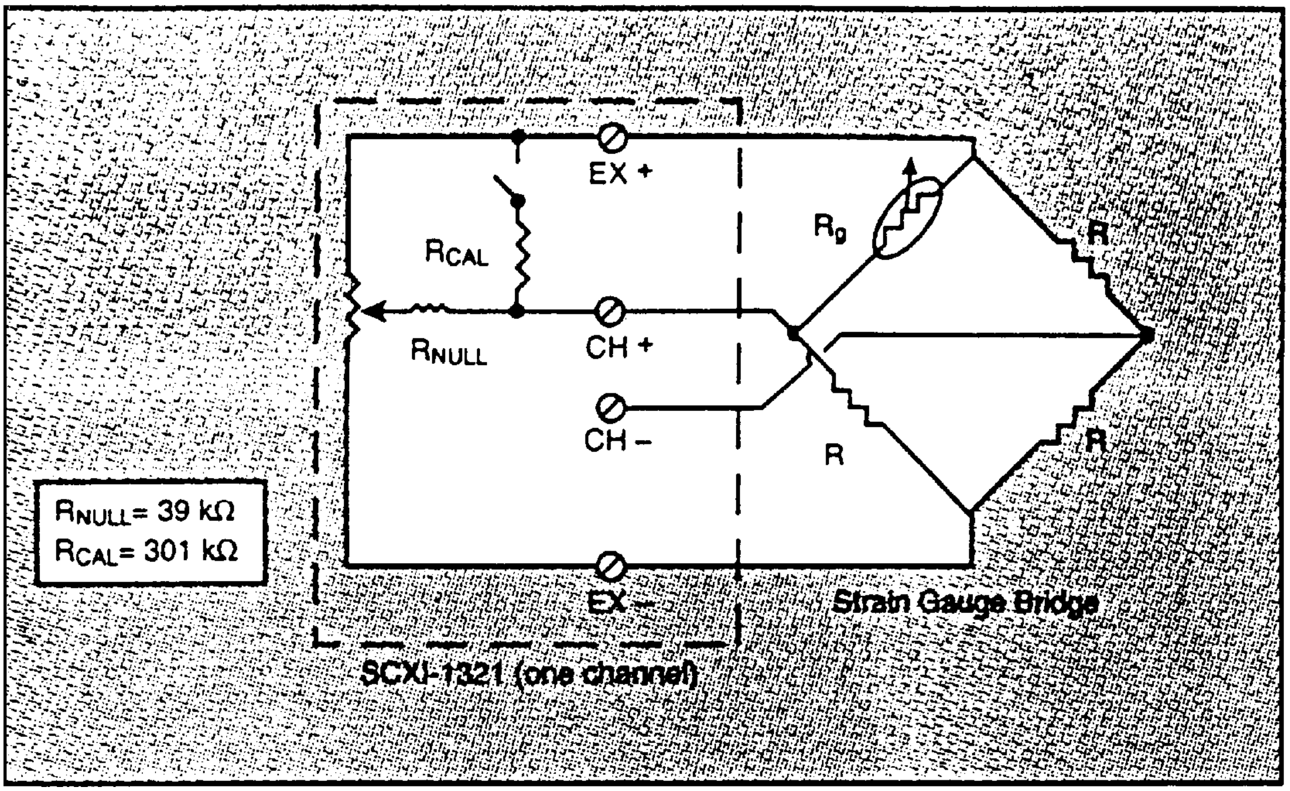


Figure G.1. Offset nulling and shunt calibration on SCXI 1321.

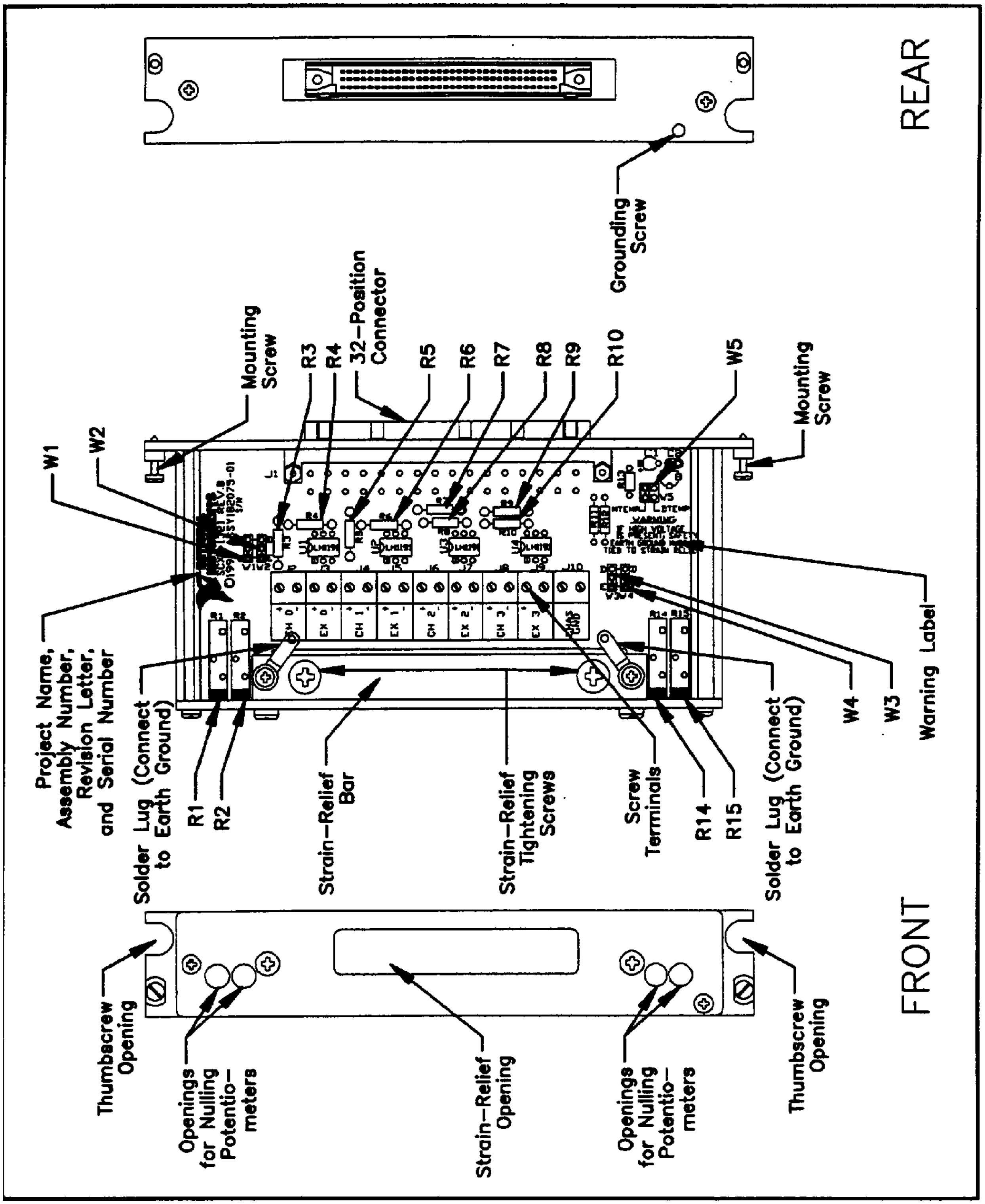


Figure G.2. SCXI 1321 terminal block.

SCXI-1121 Configuration Quick Reference

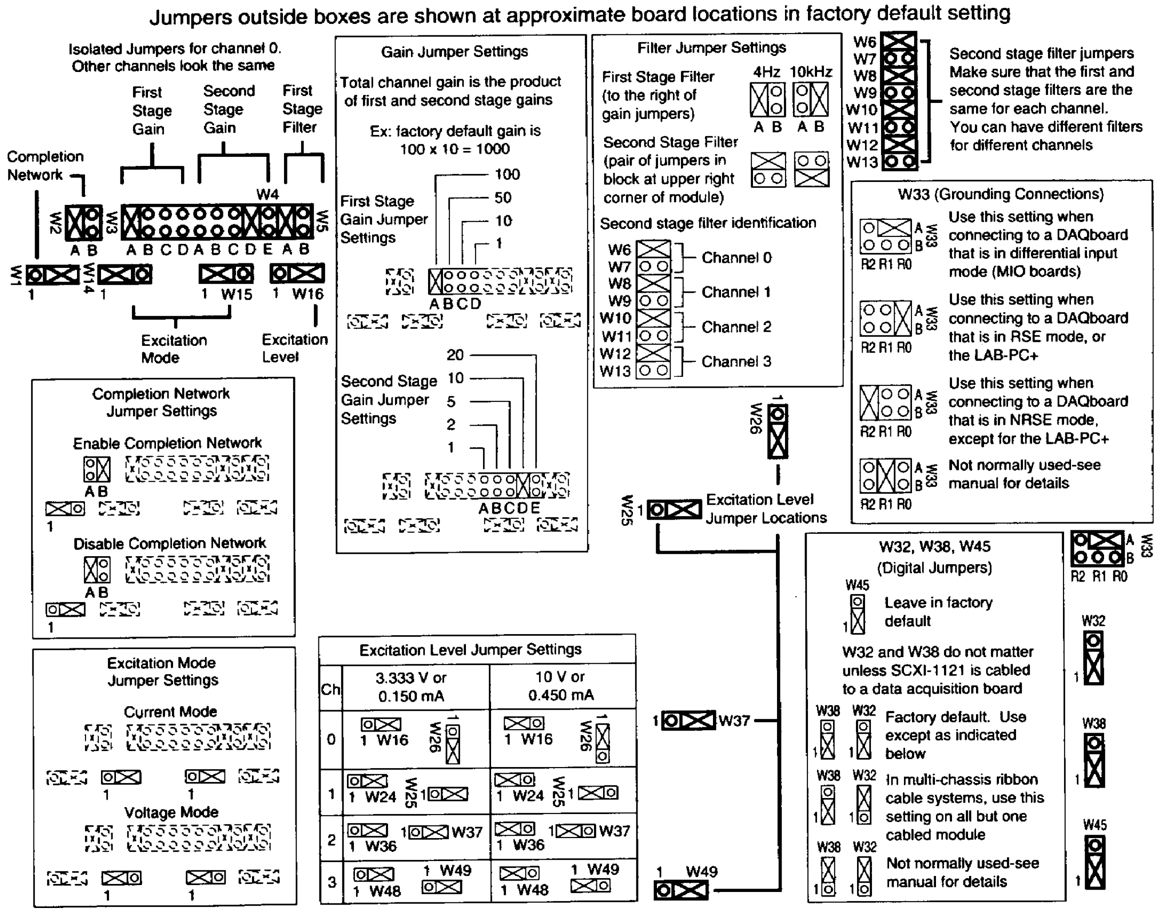


Figure G.3. SCXI 1121.

<u>**Appendix H**</u>

Network Security

Network Conventions

The following is a list of drive letter definitions for the network (daq1 and analysis1 are in the high bay of building 251, daq2 and analysis2 are in A60, and daq3 and analysis3 are in the IUF):

<u>If you are using the DAQ computer</u>

c:	main hard drive	
d:	data hard drive	
n:	hard drive c on analysis computer	(\\ANALYSIS1\ANALYSIS1-C)

<u>If you are using the Analysis computer</u>

c:	hard drive	
k:	hard drive c on DAQ computer	(\\DAQ1\DAQ1-C)
l:	hard drive d on DAQ computer	(\\DAQ1\DAQ1-D)

<u>From a remote computer</u>

o:	hard drive c on DAQ1 computer	(\\DAQ1\DAQ1-C)
p:	hard drive d on DAQ1 computer	(\\DAQ1\DAQ1-D)
q:	**hard drive c on analysis1 computer**	**(\\ANALYSIS1\ANALYSIS1-C)**
r:	hard drive c on DAQ2 computer	(\\DAQ2\DAQ2-C)
s:	hard drive d on DAQ2 computer	(\\DAQ2\DAQ2-D)
t:	**hard drive c on analysis2 computer**	**(\\ANALYSIS2\ANALYSIS2-C)**
w:	hard drive c on DAQ3 computer	(\\DAQ3\DAQ3-C)
x:	hard drive d on DAQ3 computer	(\\DAQ3\DAQ3-D)
y:	**hard drive c on analysis3 computer**	**(\\ANALYSIS3\ANALYSIS3-C)**

If you reboot one machine when the other is not logged onto the network, you will get a warning that 'network drive ##### could not be reconnected', choose "OK" or if you are asked whether to reconnect drive in future choose "yes".

When you reboot the analysis or DAQ computers, they prompt you for a login and password. The login is either daq or analysis, the password is bstrain.